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POWER

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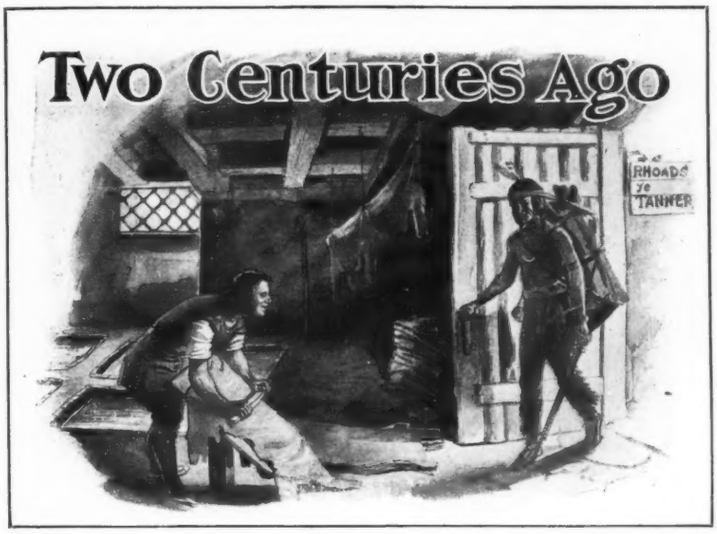

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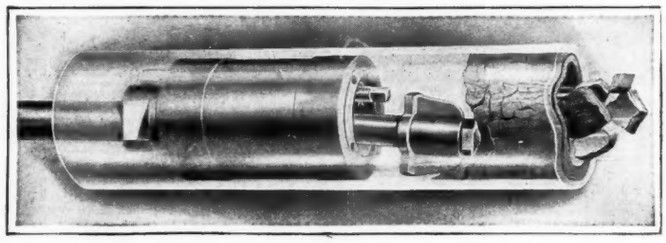

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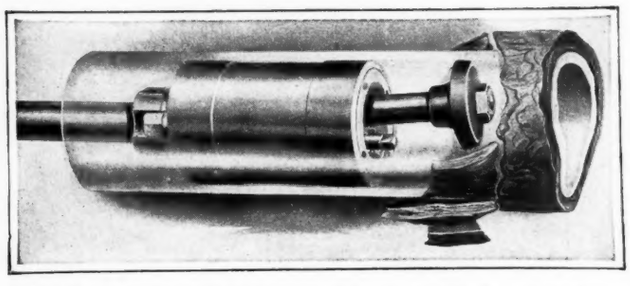

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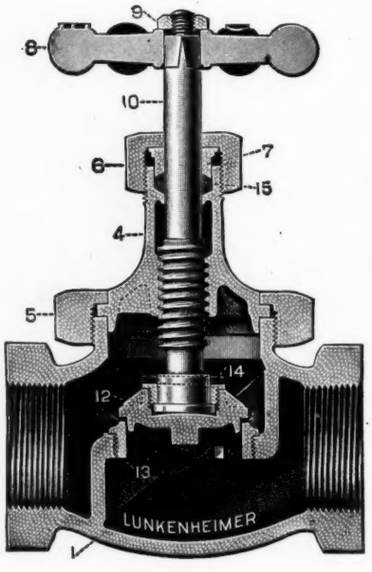

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No. 4

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¶ And while mechanical cleaners, *will clean out* more or less scale

¶ If you *allow* it to encrust the boiler tubes,—

¶ Yet you must see for yourself that they cannot possibly do any permanent good—regardless of how effectual the temporary work they might be able to accomplish.

¶ And while there's scale in the boilers, no matter how little, there's loss in coal, in time, in boiler efficiency.

¶ The best way to tackle scale is *not to let it form at all.*

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¶ Then you'll get the full benefit of all the heating surface—all the time.

¶ You'll have no burnt tube ends, no bagging, no corrosion, etc. Then the aid of mechanical cleaners will be unnecessary.

¶ That's the method used by the Dearborn Laboratory—that is the logical method of treating scale.

¶ We analyze 8000 samples of feed water annually, which gives you an idea of our splendid facilities.

¶ Suppose you send us a gallon of *your* boiler feed water—we'll analyze it, find out what scale forming elements it contains—

¶ And let you know exactly how much Dearborn Treatment, which will counteract these elements, will cost. Do this today.

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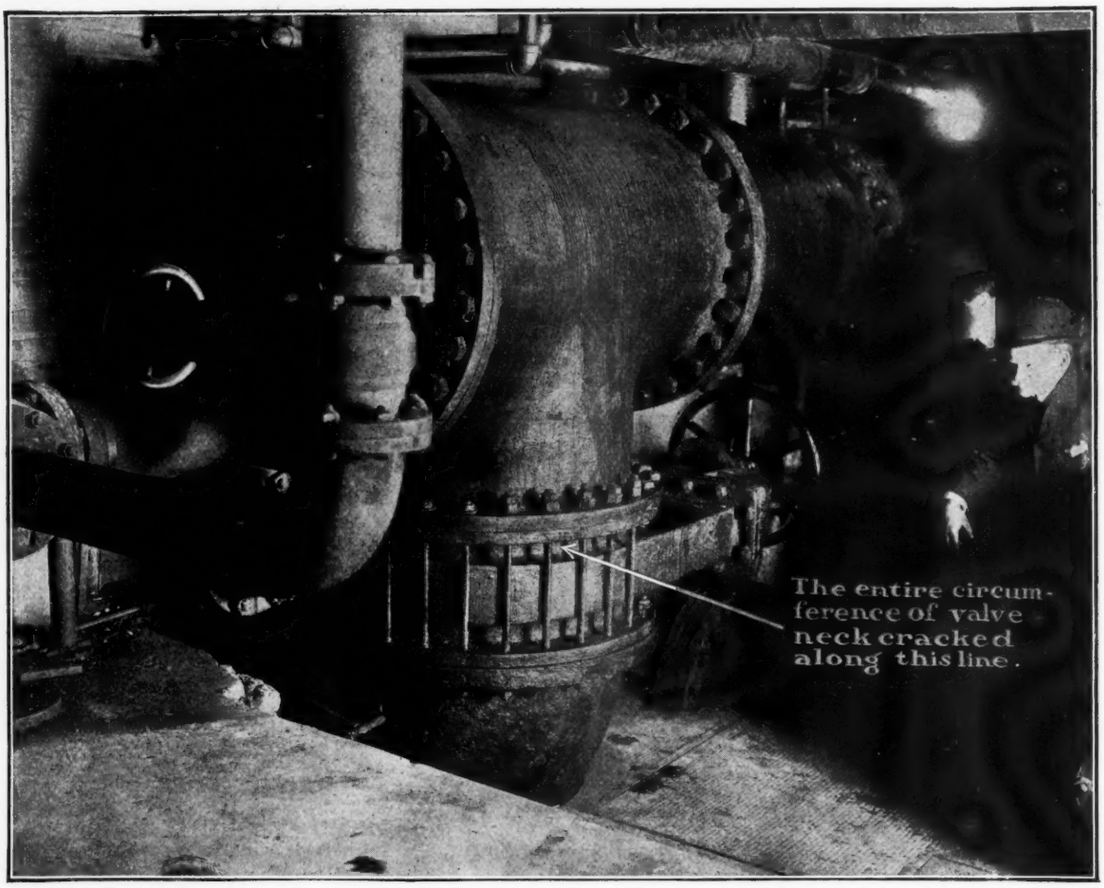

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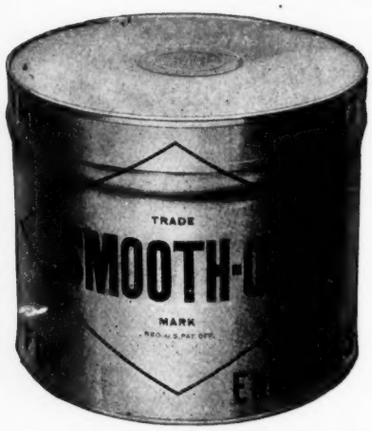

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POWER

Vol. 35 NEW YORK, JANUARY 9, 1912 No. 2

Old joke No. 53, series K: "A camel can go eight days without taking a drink. But who wants to be a camel!"

Variation: Most engineers are good fellows. But who wants to be an engineer!

You may take it from one who knows, the engineers, by and large, are the hardest-worked and least-appreciated class of men.

This is due entirely to ignorance—some ignorance on the part of the engineer himself and much ignorance on the part of the employer and the public in general.

The average employer thinks that the engineer is only a mechanic, a man who is called upon to use his muscles more often than his intelligence. He does not realize that to generate power continuously and cheaply, and to get the best work possible out of a given equipment, require a man of much education, experience and intelligence.

The general public seldom thinks of the engineer at all.

What a pretty pickle indeed all of us would be in if the engineers and firemen were suddenly unable to do a tap of work some cold morning.

To begin with, about everyone who did not own a horse or an automobile would have to walk down to work as no cars would be running.

Then, when the office was finally reached there would be a stair-climbing stunt to perform because none of the elevators would be in service.

Next, there would be no heat—without engineer and fireman, even the heating system would be useless. And with the mercury down around the freezing point this would be serious.

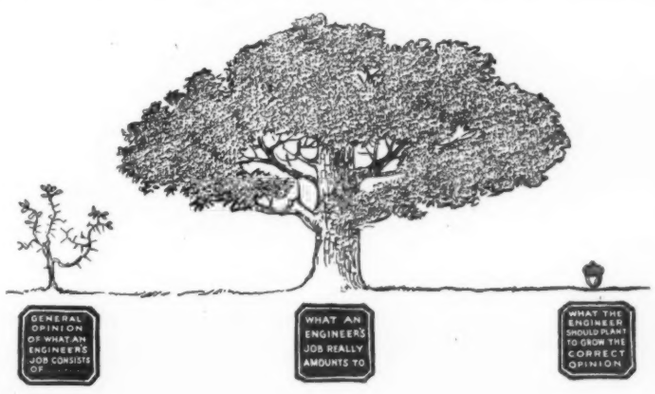
In the mills and factories the hands would be compelled to take a day off, for without power to run the manufacturing machinery, the workmen would be helpless.

Now, the engineer himself knows all this—it is an old, old story to him. But the public remains in blissful ignorance.

The whole trouble is this: While the importance of mechanical power has grown enormously, the public estimation or appreciation of this fact has grown hardly at all.

It is up to the engineer to educate the public concerning himself and his work. He has neglected this too long as it is. The sooner he does it, the sooner will he come into his own.

At one of its recent meetings the American Society of Mechanical Engineers came to the conclusion that the general public needs educating along all lines relating to technical matters and it has undertaken to supply the same.


GENERAL OPINION OF WHAT AN ENGINEER'S JOB CONSISTS OF
WHAT AN ENGINEER'S JOB REALLY AMOUNTS TO
WHAT THE ENGINEER SHOULD PLANT TO GROW THE CORRECT OPINION

It occurs to us that various operating engineering bodies can well take up work along similar lines.

Power System Cleveland Cliffs Iron Co.

By C. A. Tupper

General description of the power system which is now being installed for the operation of the various mines of the Cleveland Cliffs Iron Co.

The system when completed will consist of one large hydro-electric plant supplemented by two steam plants, each distributing current at 60,000 volts over an area of 40 square miles.

The Cleveland Cliffs Iron Co. is constructing a hydro-electric power system which will serve all of its mines on the Marquette range, a district in which this corporation is the largest operator. The Carp River is being harnessed and about 6000 kw. will eventually be developed. The project is the second of its kind upon which this company has embarked, the first having been on the Au Train River, and is one of the most important undertaken in upper Michigan. Much important preparatory work has been done with the installation of a large quantity of electrical machinery at the mines and shops, including motor-driven trams, hoists, pumps, compressors, tools, etc., the construction of transmission lines, and the establishment of two large central generating stations, equipped with steam turbines, which now furnish the power required and will later serve as auxiliaries to the hydro-electric plants.

Concrete Dam

The site chosen for the water-power station is a mile from the point at which the Carp River empties into Lake Superior, being located at the foot of Mt. Mesnard. The concrete dam now under construction is about four miles from the generating plant. Its spillway is 120 ft. long and 48 ft. high, and secure protection against washouts has been provided by a curved retaining wall 150 ft. long and 7 ft. wide, reënforced horizontally with old cables at the point where it joins the main spillway.

The water will be carried to the wheels in a steel and stave pipe line 21,500 ft. in length, and 60 to 66 in. in diameter, 8567 ft. being of lock-bar steel, 2233 ft. of welded steel and the remainder of wooden staves. A surge tank 16 ft. in diameter and 130 ft. high will be placed at the top of Mt. Mesnard; the available head is about 600 ft. At the power plant two 3000-kw. Allis-Chalmers hydraulic turbine units and three 1900-kilovolt-ampere transformers are being installed. The system is designed to carry 60,000 volts, but, for the present, current, will be transmitted at 30,000 volts. It is expected to have the new plant in operation early next spring.

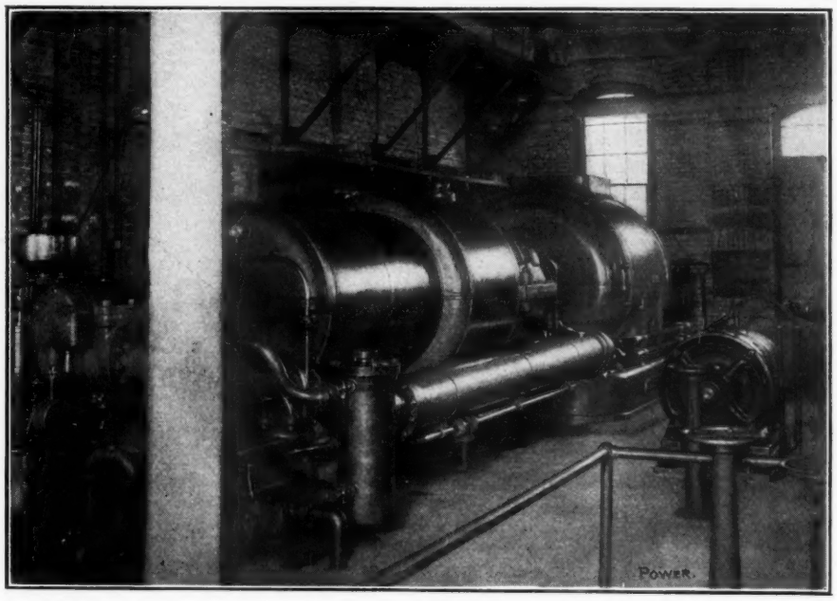


Fig. 2. 1500-kw. Turbine at Maas Mine Plant

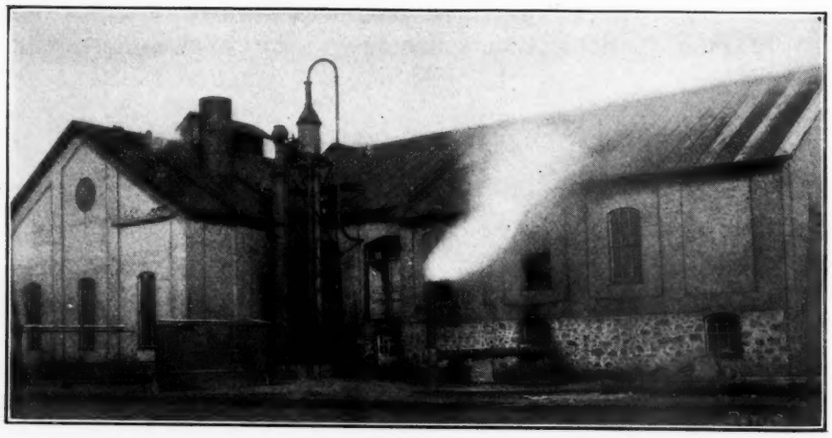


Fig. 1. Exterior View of Maas Mine Plant, Showing Condenser

Transmission Line

The transmission line under construction, which consists of No. 2 B. & S. solid-copper cable carried on steel towers, will connect the Mt. Mesnard power house with the auxiliary and distributing station already in service at the Maas mine, Negaunee, which is in turn connected similarly with a plant of the same kind at the Princeton mine in the Swanzy district and with the Cleveland Cliffs properties in the Ishpeming and North Lake fields. Altogether the transmission system covers a territory of 40 square miles, and there will be a double circuit over the entire line.

Steam-turbine Plant

The steam-turbine plant at the Maas mine (see Fig. 1) is laid out in accordance with good engineering practice. The boiler room contains four 350-hp. Stirling boilers, with Murphy stokers, the furnace fronts being set out 7 ft. from the boiler fronts. This gives room for bins directly over the furnaces, which are supplied with slack coal by cars which run over the top of the bins and which are raised by a steam-hydraulic elevator. Induced draft is provided by a Sturtevant engine-driven fan, delivering the products of combustion to a 25-ft. steel stack set inside the building on a concrete foundation.

Engine Room

In the engine room all the auxiliaries, except the exciter and switchboard, are placed beneath the concrete floor. The electric-generating apparatus consists of a 1500-kw. Allis-Chalmers steam-turbine

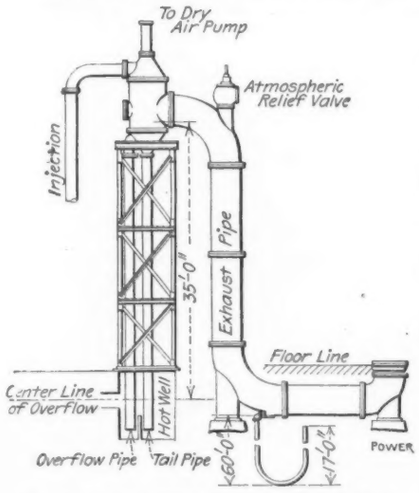


Fig. 3. Condenser with Automatic Drain Trap

set, which delivers three-phase, 60-cycle current at a terminal pressure of 2300 volts. The turbine receives steam at about 150 lb. pressure and exhausts at about 28 in. vacuum to an Allis-Chalmers condenser, of the barometric type, which consists of a 42-in. head provided with an air cooler, water distributor, spray plates and equalizing pipes. With this is operated a horizontal, double-acting, rotative dry-air pump, with cylinders in tandem, protected by a water and air separator on the condenser head; also a motor-driven centrifugal pump for circulating the condensing water, and a small drain pump for automatically removing the condensation from the exhaust piping. The latter pump, however, is used only in emergencies, as the exhaust line is drained by a 3-in. pipe which runs down the shaft a vertical distance of 60 ft. and then turns up vertically for a distance of 17 ft. This automatically seals the vacuum and allows any accumulated water to drop down the shaft, as shown in Fig. 3. A 10-in. motor-driven centrifugal pump lifts the water from the hotwell to the top of a cooling tower from which it is returned to the injection system after being cooled as falling spray. Approximately 3125 gal. are used per minute.

There is a completely equipped switchboard, and current is led from the busbars to three oil-insulated, water-cooled transformers having a capacity of 500 kilovolt-amperes each, which step up from 2300 volts to 30,000 volts for transmission. As the transmission line will be operated when necessary at 60,000 volts, the transformer secondary coils are so wound that they may be adapted to that voltage by changing the connections.

In addition to the generating unit, the station at the Maas mine contains two steam hoists and a two-stage air compressor furnishing 4800 cu.ft. of free air per minute. The Princeton station is similar to the Maas station.

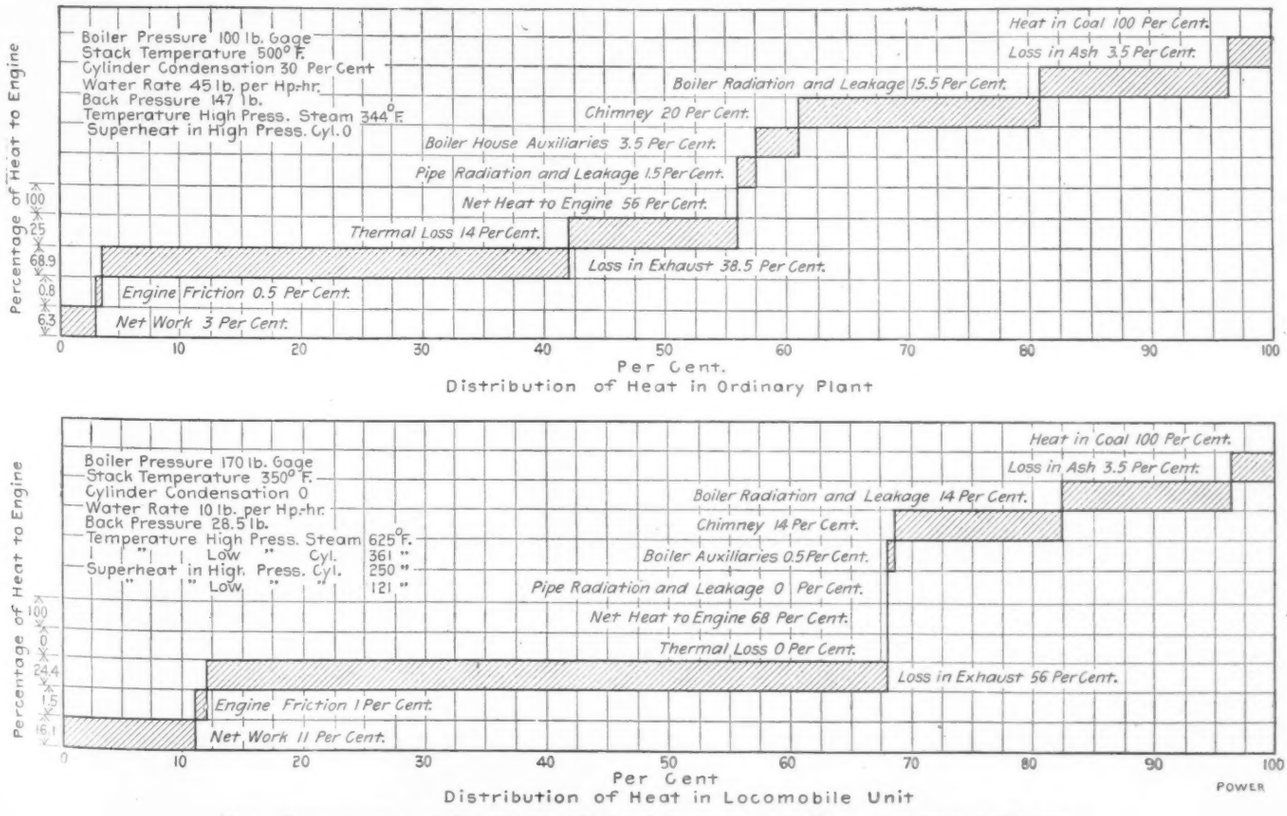
The work is being carried out under the supervision of O. D. McClure, resident engineer for the company, and Viele, Blackwell & Buck, of New York, as consulting engineers.

Locomobile vs. the Small Plant

By G. A. Glick

The accompanying chart is compiled from a number of recent articles in various technical papers concerning the locomobile unit. The type of locomobile unit referred to in the present case is a tandem-compound engine mounted on top of the boiler, the high-pressure cylinder being set in the stack and the low-pressure cylinder in the steam dome. High-pressure steam is used and superheat in both cylinders. Superheating the steam between the high and low cylinders is one of the features of the engine. All the boiler and engine auxiliaries are mechanically driven, and a high vacuum is used, the condenser usually being part of the unit. The engine is built in small sizes and some remarkable results are claimed, such as one indicated horsepower-hour on 10 pounds of steam, and one indicated horsepower-hour on 1.3 pounds of coal.

The advantages of the locomobile are that the stack temperature is low, the boiler and engine auxiliaries are mechanically driven, all piping is very short, thus reducing radiation, and the super-



Heat Distribution in Locomobile Unit Compared with That of Ordinary Plant

heat overcomes the cylinder condensation. The very savings themselves help because they in turn cut down the size of the boiler and therefore the boiler radiation.

Compared to this unit as described is the ordinary small plant of 100 horsepower, which usually runs noncondensing. The example may be in the other extreme, but many such plants exist.

The chart shows the heat losses in both types, and some comparison may be made of the magnitude of these losses.

The locomobile has been in operation in Germany for some time and is a decided step toward advancement. Several features look dubious to steam practice in this country, such as 625 degrees Fahrenheit initial temperature, and the high vacuum of 28.5 inches of mercury, corresponding to 90 degrees Fahrenheit. The unit probably has some disadvantages in the way of a better class of labor being required for operation and a better grade of oil for the cylinders; but if the actual saving in coal is reasonably near the figures here calculated, the unit would without doubt be a great saver in the cost of operation.

Care of Belting in the Factory

By A. E. Derby

Suggestions as to keeping belts clean and removing oil, the proper lacing and the use of belt dressing with simple directions for testing it.

It is very important that a man operating belt-driven machinery know how to properly glue, lace and clean a belt; keeping it clean is a big factor in the life of a belt. There are many things that happen for which the operating man is blamed that are no faults of his, as there are many mistakes made in placing machinery that will always cause belt troubles. However, it is always well to know where to look for them and a little forethought when ordering the machinery set will often avoid many later troubles.

One plant of which the writer had charge, had a muleshaft running a right-angle turn, with a 12-in. heavy double belt 68 ft. in length. On account of its getting saturated with oil and the pulleys being too small, causing them to run at too high a speed on cast-iron bushings that stuck to the shaft because they heated so rapidly and requiring the oil to be kept running all the time, they caused all kinds of trouble and necessitated a shutdown of one entire department of the plant. This was rectified by taking off the 24-in. pulleys and using bronze bushings on two 48-in. wood pulleys, thus reducing the speed from 360 to 180 r.p.m. No more trouble was experienced, and the oil could not reach the belt after the change. As a rule, most muleshafts are fitted with small pulleys, which is bad practice.

Another poor arrangement was a lineshaft placed under a row of emery-wheel arbors employing 4-in. heavy double belts running at a speed of 2000 r.p.m. with a 12-in. driver and a 4-in. driven pulley, the lengths of the belts being 6 ft. They gave considerable trouble until equipped with small tighteners and glued joints. Before the change a row of 20 of these kept a man busy lacing them nearly all the time, but they gave very little trouble after the change.

If running an exhauster or blower or other high-speed machine and all of a sudden the belt slips to one side, it is necessary only to wrap a piece of cotton cloth about 1 in. wide for six or eight thicknesses around the crown of the pulley in the direction the belt runs. This should not be depended upon for lasting many days as it is only a means of saving the belt at the proper time.

When a laced belt runs over to one side of the pulley, it may be turned over to run on the other side, and if this does not make it run on the center of the pulley the lacings should be taken out and one end of the belt cut at an angle, about ⅜ in. to every 4 in. of width, at the side to which it slips; then relace as shown in Fig. 1. Belts should never

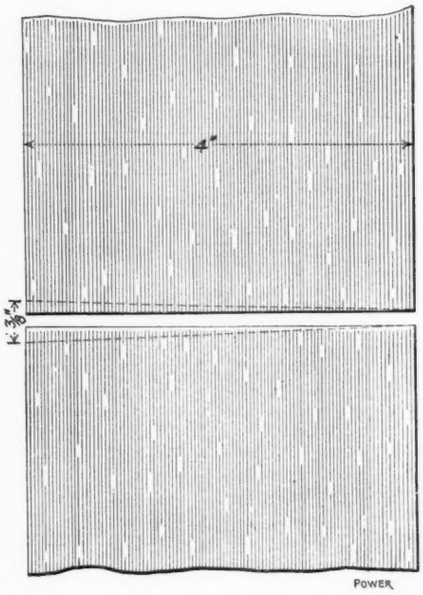


FIG. 1. SHOWING PIECE TO BE TAKEN OUT TO PREVENT RUNNING TO ONE SIDE

be allowed to run against sticks or rods to keep them in place; this destroys the edge by causing it to open up and become longer on that side.

One cannot be too particular about keeping the belts clean, as it is safe to say that 99 per cent. of the factories are run without a moment spent in cleaning belts, while every week some time is allotted to cleaning the machinery which they run.

To clean a leather belt take a stiff scrubbing brush with some benzine or gasoline and scrub vigorously on the running side. Then scrape with a metal or hard-wood scraper and wipe thoroughly dry. Apply a little neatsfoot or castor oil to tone up the leather. A better way is to have a round tank made with a cover and a drip near the bottom; it should be large enough to accommodate the belts used in the factory, and deep enough to cover them when raised a little off the bottom. Fill to the top of the belts with benzine or gasoline and allow them to soak; then squeeze them between rollers or a press to force out all the grease, and finish as before mentioned.

By taking care of the old belts they can be cut up and made into smaller ones. They can be ripped square on a rip saw, but it is not necessary to use the best saw for this purpose; one of small diameter may be used and it only needs to run a little above the table over the thickness of the belt.

When repairing belts do not fill them with iron rivets or hooks; use wood pegs, as they will cut up and not injure the tools used, and it is much easier to repair and make them over into smaller sizes.

The best way to fasten belts is to glue them, and no stretchers are needed when the length plus the lap is known. Take a short board a little wider than the belt and nail both ends on the board with the lap square; have the belt off of the pulleys and then glue; leave it there until dry; then pull out the nails and the belt is ready. The lap should be made 1½ times the width of the belt; if the leather is old the lap should be twice the width of the belt.

To have a rawhide lacing last, the holes should be in line with the joint of the belt and if the belt is heavy and running at high speed over small pulleys, a hinge joint should be employed. To lace a hinge joint, make two rows of holes ¾ in. apart, with one hole less in the back row; start the lace in the center holes with the middle of the lace and go to both edges and re-

turn. Every stitch should be turned through the belt joint; then finish in the center with a knot through a slit in the other end of the lace. (See Fig. 2.)

Wire lacing is good, but it has its drawbacks as it breaks at the edges of the joint first, causing the end to stick out and being dangerous to those who handle it. It also requires considerable time to repair, it being necessary to take the belt away to the machine that prepares it for the wire. It should not be used where the belts are handled with the hands while in motion. There are many metal belt fasteners that are useless for the same reasons, and they destroy the face of wooden pulleys and soon break the leather across the belt at the back of the fastener.

When using tighteners or guide pulleys always apply them to the slack side of the belt and near the driven pulley. An arrangement for adjustment should always be made at the heel of such pulley frames, as the least movement, in or

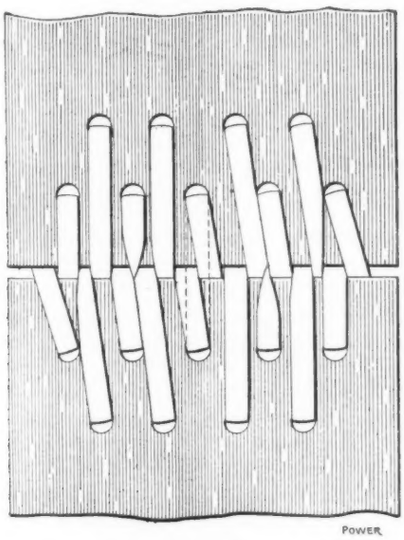


FIG. 2. METHOD OF LACING BELT

out, up or down, will make a great difference in the position of the belt on the driven pulley while running.

The strongest part of the leather is near the flesh or the rough side of a belt, but it is best to run with the grain or hair side on the face of the pulley, because this side is liable to crack when stretched after the belt has been in use some time; therefore, it is better to crimp than to stretch it.

Keep the belts free from the accumulation of grease and dirt, especially with lubricating oils, and do not let them run until they are hard and brittle on the running surface before applying a good belt preservative.

One should be careful as to the belt dressing used, as there are many on the market that are worthless. The points to be considered in belt dressings are lengthening the life of the belt, keeping a belt from slipping and the length of time it will last after being applied; does it pay to use it, and will it mix with the oil used about the machinery? First, to lengthen the life of a belt simply means keeping the belt clean, applying a preservative when the belt is seen to be getting hard; then use a dressing that is an oil and water repellent. Second, keeping a belt from slipping excessively is one of the hardest problems as a belt slips when the load is too great to be overcome by the adhesion of the belt in the condition that it is in and at the speed at which it is traveling. It is better to change the condition of the belt than to fill it with belt dressing. When the load is so great that the belt stands still and the driving pulley continues to revolve, it then burns the leather, and no amount of belt dressing will overcome such conditions. One must look elsewhere in order to have the belt perform its duty. A belt too tight means bearing troubles; therefore, the belt man must be able to tell his employer where the trouble is; this means good belt running in place of belt destruction. Third, as to how long a belt dressing will last after being applied may be judged from the following: Does it gather on the pulleys and belt in chunks and then fly about the room? This is the case in dusty and dirty places. Does it mix with the machine oil and become useless by filling the belts with a compound of machine oil and belt dressing? Under these conditions does it pay to use it? Fourth, if it mixes with the oil used about the machinery it only increases the oily condition, which is the cause of most belts slipping when they are in line, not too loose and of the proper size to do the work required.

Having experimented with belt dressings the writer found the following simple tests to overcome a large amount of trouble and expense: Take a piece of clean tin, pour onto it a quantity of the dressing equal to the size of a quarter, place over a small fire and heat until it smokes. If there is any rosin present, it will show many small, bright spots on the tin as rosin will clean tin. Now take a small bottle, add about half and half of belt dressing and machine oil and see if the two readily mix. If they do not, shake well or heat together, and if they mix when heated allow them to cool and see if they separate. If the dressing is too thick to mix when cool, make it thin by heating and then mix, and if they do not separate while cooling it is safe to assume that the dressing will be useless on oily belts. Never allow any rosin to be used on leather belts, as it soon rots the leather at the lace holes and joints where the fiber of the leather is exposed and the rosin accumulates.

Commercial belt dressings are used for making belts stick to the pulleys and to preserve the belt. The substances used in manufacturing these preparations include stearic acid, degras, rosin, castor oil and fish oil. Careful tests seem to indicate that the coefficient of friction is influenced directly by the absence of air or other substances between the belt and pulley, and that the best results are obtained when the belt is in direct contact with the pulley.

In conclusion, it may be said that a good dressing should not decompose, become rancid with age, be influenced by moisture, dry up, nor cause the belt to stick to the pulley when idle, as though glued there and when starting pull off the surface pieces that expose the fiber; instead it should soften the pulley side of the belt, penetrate the fiber, leaving no film on the surface, and in addition lubricate and protect the fiber from crumbling. It should prevent the generation of electricity by friction, and it should contain no mineral acids. A dressing fulfilling these specifications will not injure the belt and may be used with impunity.

The Purpose of Oil*

BY GEORGE J. STOLL

The primary purposes of oil are twofold: (1) Cooling. (2) The forming of a film, the molecules of which move among themselves like an infinite number of ball bearings to prevent the rubbing of the bearing surfaces. All mechanical motion produces heat. Heat in machinery produces uneven expansion with a resultant increase in friction. To keep the bearings cool is one of the important functions of oils.

For lubrication just the oil needed must be applied to the bearing. For instance, in the heavy, loose bearings there is great need for oil of high viscosity or body, because the thinner oil has a tendency to be pushed aside and will not cling tightly enough to the surface. To illustrate this point, consider a small circle within a larger one and touching it while spinning on its own center. The smaller circle represents the shaft, the larger the socket in which it runs. From this it may be seen that the tighter the bearing, the greater the surface on the shaft which touches the socket in its rotation. Thus on a loose bearing, where the circles are not so near the same size, there is more of a tendency to rub off the oil. On the tight bearing the opposite condition is presented. An oil must be used that will be thin enough to get in between the close-fitting parts and still give satisfactory lubrication. For instance, dynamos or turbines have tight bearings, and must have an oil of comparatively low viscosity.

The question arises, What effect has fire test? For the same viscosity, fire

*Abstract of lecture delivered before Kentucky No. 1, N. A. S. E.

tests vary with the different crudes. Why is it that Pennsylvania oil, having light gravity and viscosity, is often better than a Western lubricant of much higher viscosity and much heavier gravity? Conceive a bearing in motion—a small speck of dust or foreign matter, such as a little particle of waste, gets between the surfaces; it may be almost microscopic, yet it immediately produces great heat. A cheap oil of low fire test will tend to vaporize. The higher the fire test the slower the oil will vaporize, and a dynamo must have an oil that will not vaporize, but will remain there and cool the heated bearing immediately—an oil that will go to the spot. Were it not for just such troubles as this there would be little difficulty about proper lubrication. The above principles may seem elementary, but their proper application may save many difficulties. Recently a salesman called upon a large manufacturing concern, whose buyer said, "I take a pretty good oil; give me a good oil of good body; I have been paying 18 cents per gallon." The salesman accordingly ordered a heavy, viscous engine oil to produce the body desired. He did not know anything about the conditions inside the plant. He merely took the man's statement that he wanted body to the oil. That plant had very rapid-moving machinery with tight, close bearings; therefore the oil was too heavy to get to the spot quickly and the result was disastrous. He should have had light-bodied oil of an entirely different character. Both were the same price. On one the emphasis was placed on "viscosity," on the other, "fire test."

Lubrication within the cylinder requires an oil that will atomize with the steam and get to the cylinder wall to produce lubrication around the piston head. For the purpose of assisting both in the atomizing and the lubrication—that is, to help the oil emulsify—animal oils as low in acid as possible are often used. Cylinder stock of about 600 degrees fire test, as free as possible from any taint of tar and compounded properly with animal oils, is usually the best for ordinary wet steam, because it spreads better in this medium than does the mineral cylinder oil or the higher fire-test goods. Of course, in many instances where the exhaust steam is used over, it is impossible to use a compounded oil. For the high pressures which have high heat it is usually desirable to use an oil of about 650 fire test unfiltered, free from tar, and any compounding must be done with great care, because poor compounds of animal oils are subject under high heat to be broken up into acids, as stearic acid, which will attack the walls of a cylinder and pit them seriously.

It will now be apparent that the engineer has but a few elements to work with, but he can compound them in an almost endless variety, though this must be done carefully. Not only must first-class stocks be used, but they must be carefully and intelligently applied.

The Large Delray Boilers

Discussion following the presentation of Dr. Jacobus' paper upon the tests of the boilers at the Delray station of the Detroit Edison Co. This paper appeared in abstract in the Dec. 5 issue.

The discussion, of which this is an abstract, followed the presentation at the recent meeting of the Mechanical Engineers of a paper by Dr. D. S. Jacobus detailing tests conducted upon two boilers of over 2300 hp. rated capacity each, at the Delray station of the Detroit Edison Co. The paper was abstracted in our issue of Dec. 5 and is available in its entirety in the *Proceedings* and *Journal* of the society. The tests showed efficiencies of over 80 per cent., and a single boiler furnishes steam for an 8000-kw. unit.

R. D. Rice, of the General Electric Co., commented upon the absurdity of rating boilers by horsepower, and pointed out that the tests gave no indication of the comparative merits of the two stokers except so far as their efficiencies are concerned. The other items, such as ease of handling, smokeless combustion and cost of maintenance, which, to the mind of an engineer, are essential, do not come within the scope of the paper.

The blowing off of 75,000 or 100,000 lb. of steam into the atmosphere in the case of a sudden stoppage of the turbine is a serious matter, and in such installations means will have to be taken to protect the boiler by the immediate injection of a large amount of feed water in order to reduce the temperature. Tests with a flow meter have shown that a boiler can have its output reduced almost to zero in a short time by the introduction of cold feed water, and these experiments indicate in the case of such large units the necessity of an arrangement for an accurately graduated feed following closely the demand for steam on the boiler, so that the disturbance by the feed of the steam capacity of the boiler can be reduced to a minimum while maintaining a constant pressure.

In these large units fluctuations in feed supply are likely to lead to large fluctuations in pressure when operated as single units. Furthermore, the stresses on the boiler due to expansion forces will be greatly reduced by the use of such graduated feed.

R. E. DeWolf submitted some curves, the first of which, Fig. 1, shows that for the two boilers, built by the same company, from identically the same specifications, a considerable difference exists in the drop of pressure through the superheater under the same working conditions.

In Fig. 2 are shown the input and output in units of 1,000,000 B.t.u. for the boiler equipped with the Roney stoker; the points marked 2-4 and 5-6 include the period between tests and are, therefore, at a somewhat lower efficiency.

The same curve for the boiler equipped with the Taylor stoker is shown in Fig. 3. Here again the point including the period between tests and the point 15, which includes 7½ hours of banking, are below the curve. Fig. 4 shows the variation in temperature of the flue gas with the rate at which the boiler is run; and Fig. 5 the relation between the percentage of CO_2 and the rate at which the boiler is operating.

In Fig. 6 is given the percentage of steam which is used by the boiler auxiliaries; that is, the stoker engine and the turbine operating the fan for the Taylor stoker. The lower full line curve shows the steam used by the steam jets in the Roney stoker. The dotted curve is purely theoretical, being taken at 25 per cent. of the Taylor curve, and is intended to indicate in a general way the loss of heat energy from the steam used by the stoker engine and the turbine for the Taylor stoker equipment.

H. O. Pond, of Westinghouse, Church, Kerr & Co., who presented the paper in the absence of the author, showed a number of lantern slides from photographs taken during erection, from which we have selected those shown in Figs. 7 to 10, inclusive, as giving an idea of the magnitude of the work.

He said that in a plant with less excellent feed water the advisability of using such large units would be somewhat questionable. The most striking point to him in the test was the small difference in efficiency (only about 6 per cent.) shown in a range of over 100 per cent. in capacity. With boilers showing such sustained efficiences it would seem advisable to run all the boilers all the time instead of banking many of them as in present practice.

Prof. W. D. Ennis said that in a curious old autographic letter by James Watt, which he had recently seen, Watt refers to a "colossal" new boiler which he was then building which exposed 300 sq.ft.

of surface to the fire, whereas his largest previous boiler contained only 170 sq.ft. The Delray boiler is not only big, it is efficient. A 75 per cent. running efficiency, including a lay-over period of seven hours, with a load varying from rating to double rating, means a great deal in power-station practice. With a turbine giving a brake horsepower on 220 B.t.u. per minute and with a brake-

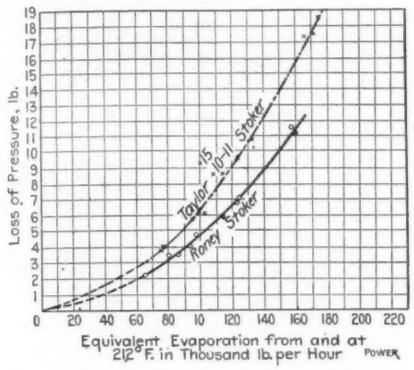


FIG. 1. LOSS OF PRESSURE THROUGH SUPERHEATER AND EQUIVALENT EVAPORATION

to-switchboard ratio of 1 to ½, it means 26,400 B.t.u. in fuel per kilowatt-hour, or about 1.9 lb. of coal. This economy was obtained, not at a 3- or 3.5-lb. evaporation rate, but at one running as high as 7 lb.

For a city power station the cost of land and buildings and interest thereon will be approximately in the inverse ratio of these evaporation rates. The big boiler is efficient commercially as well as thermally.

In some respects, the operation was not remarkably economical; the loss to

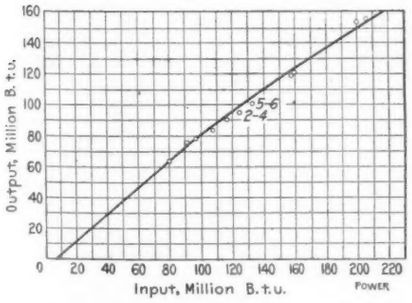


FIG. 2. INPUT AND OUTPUT WITH RONEY STOKER

the ashpit was not especially low, and it would have been a conspicuous item had the coal carried a greater percentage of ash. The flue-gas temperatures were not particularly low. The ratios of heating to grate surface (as the latter were measured) are 53 and 58½, certainly not extreme figures. The unaccounted-for (presumably radiation) loss was low, as should be expected with the low ratio of setting surface to the heat generated, which must prevail in a large boiler. This has a particularly important influence on the rate of heat transmission, because a comparatively slight radiation loss means a considerable reduction in the transmission factor, due to temperature gradient through the heating surfaces.

The explanation for the high furnace efficiency lies in the form and dimensions of the furnace, which is exactly adapted to produce a thorough mixture and impingement of the gases. With the very low draft normally carried, stratification

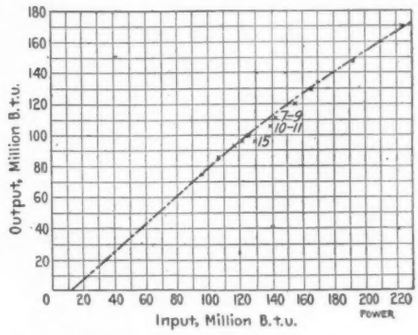


FIG. 3. INPUT AND OUPUT WITH TAYLOR STOKER

must have been almost impossible. This is demonstrated by the composition of the gas, which shows a maximum of 0.5 per cent. of CO, with the CO_2 ranging from 10.35 to 16.50 per cent. The loss of fuel heat due to the formation of CO was only 0.16 to 0.38 per cent.

In the great majority of plants where a large excess of air seems to be the normal and almost inevitable condition of operation, the best percentage of CO_2 is the highest attainable. This does not hold for such advanced practice as Prof. Jacobus' paper represents. The situa-

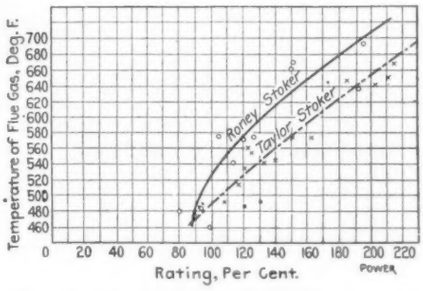


FIG. 4. PER CENTS OF RATINGS WITH DIFFERENT FLUE-GAS TEMPERATURES

tion then is somewhat as suggested by the curves in Fig. 11. As the air supply decreases, the loss due to excess air (CO_2 loss) also decreases, but at some certain point, which may be different for every furnace and every condition of operation, the formation of CO begins to be an important offsetting factor. The air supply for the best efficiency is that determined by the minimum point of the combined curve. This point has been quite closely approximated in the tests reported in the paper.

H. De B. Parsons attributed the excellent results obtained to the fact that the fire is so far from the heating surfaces and the combustion chamber is so large that a thorough mixture of oxygen and fuel can be maintained and combustion completed before the products are made to pass over the water surfaces, the distance from the grate to the tubes being about three times that in ordinary boilers.

The gas analyses show that the surplus air was only about 27 per cent. of

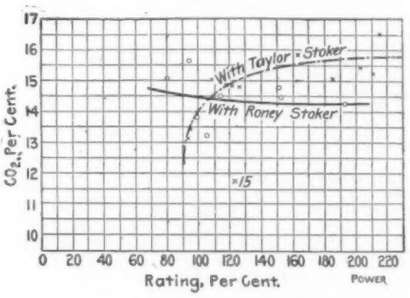


FIG. 5. PERCENTAGE OF CO_2 WITH VARIOUS RATINGS

the theoretical amount, the quantity of air supplied per pound of coal being between 14 and 14.5 lb. Under the conditions described in the paper, the theoretical maximum efficiency attainable would have been about 87 per cent.; therefore, the efficiency ratio—that is, the ratio between the actual efficiency and the theoretical efficiency—was about 89 per cent., which is truly a remarkable showing.

Horace H. Esselstyn, of Westinghouse, Church, Kerr & Co., said that they had

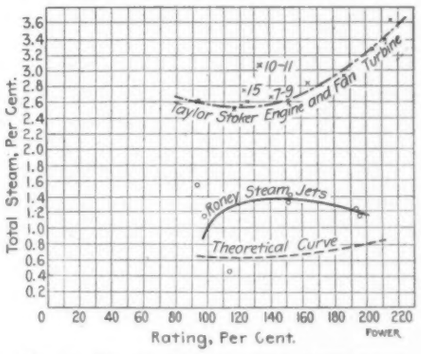


FIG. 6. TOTAL STEAM WITH DIFFERENT PER CENTS OF RATING

expected to have trouble with the brickwork of these large furnaces, and as Mr. Pond had shown the arch ultimately adopted he would show some of those tried out before it was determined upon. Fig. 12 shows the various arches tried with the Roney stokers, No. 4 being that used at the time of the test and No. 7 that still working satisfactorily. Fig. 13 shows how one of the arches came down.

E. G. Bailey, of Boston, called attention to the lack of agreement in the tests of the fuel. Out of 26 tests of

such analyses, there were only two cases where the ash reported by the Solvay laboratory was lower than that reported by the Babcock & Wilcox Co. From the average results of the two laboratories, the Solvay laboratory reported 1.39 per cent. higher ash and 300 less B.t.u. than the Babcock & Wilcox Co. On individual samples the difference between the results of the two laboratories ran as high as 3.40 per cent. ash and 929 B.t.u., or over 6 per cent. of the heating value.

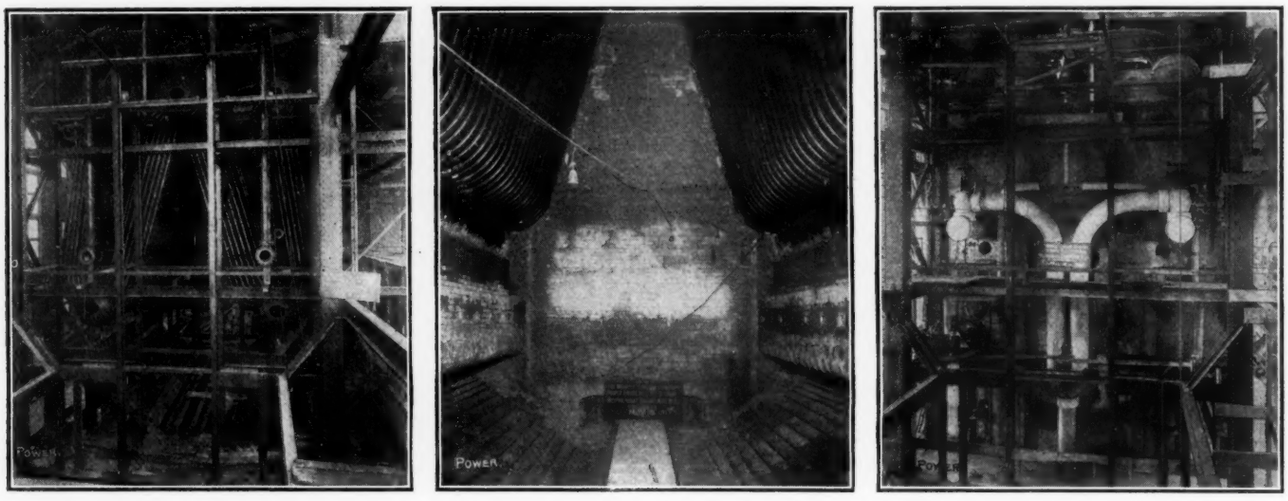
While no coal, even from the same mine, runs absolutely uniform, such variations as these are so exceptional that they cast doubt upon the accuracy of the sampling and analysis. Even the heat content, which is practically a constant for coal from a given mining district, varies 750 B.t.u., or 5 per cent. per pound of combustible, as determined by one of the laboratories, while the other reported results in which this factor varied 600 B.t.u., or 4 per cent. The variation in this factor as determined by the two laboratories from the same original sample showed variations of similar magnitude.

The erratic variations in the ash indicate that sufficient care was not used in taking and working down the samples. Properly taken, duplicate samples should have checked in each individual instance within 0.50 per cent. of ash, and the average should have been within 0.10 per cent. There are also other differences in the volatiles, heating value and ultimate analyses that indicate greater variations in the laboratory work.

A check is available on the ash by taking the weight of dry ash, as weighed from the boiler test, and correcting it for the percentage of combustible. The two laboratories agreed reasonably closely on the moisture and combustible determinations from the ash.

The average net dry ash as determined by this method is 5.53 per cent. from Red Jacket coal and 6.30 from the Milburn coal. While there is always some ash carried away by the escaping gases, it would probably be a small factor for this particular setting. If the average of 6.90 ash, as determined by the Solvay laboratory, were correct, the ash carried away by the gases would be 20 per cent. of the total ash, while the Babcock & Wilcox average of 5.71 per cent. corresponds to a loss of 3 per cent. from the grate. If any appreciable amount of ash were carried away by the draft it would be more pronounced on the test with the higher rate of combustion, but the plotting of these results fails to indicate any such relation. On the other hand, the weighed net ash on the six tests of Red Jacket coal, where the rate of combustion was below 20 lb. per square foot of grate per hour, is 5.38 per cent., while on the three tests having a rate of combustion of about 30 lb. it was 6.62 per cent. The general conclusion to be drawn from this is that the true average ash in the coal used was about ½ per cent. lower than the average of the two sets of laboratory determinations.

The heating value per pound of combustible corrected for sulphur, as determined in two laboratories, was about 3 per cent. below the corresponding results obtained by the United States Geological Survey and the West Virginia Geological Survey. The latter results agreed closely with the work of other laboratories that have had their calorim-



FIGS. 7 TO 9. SHOWING VIEWS OF THE BOILER UNDER CONSTRUCTION

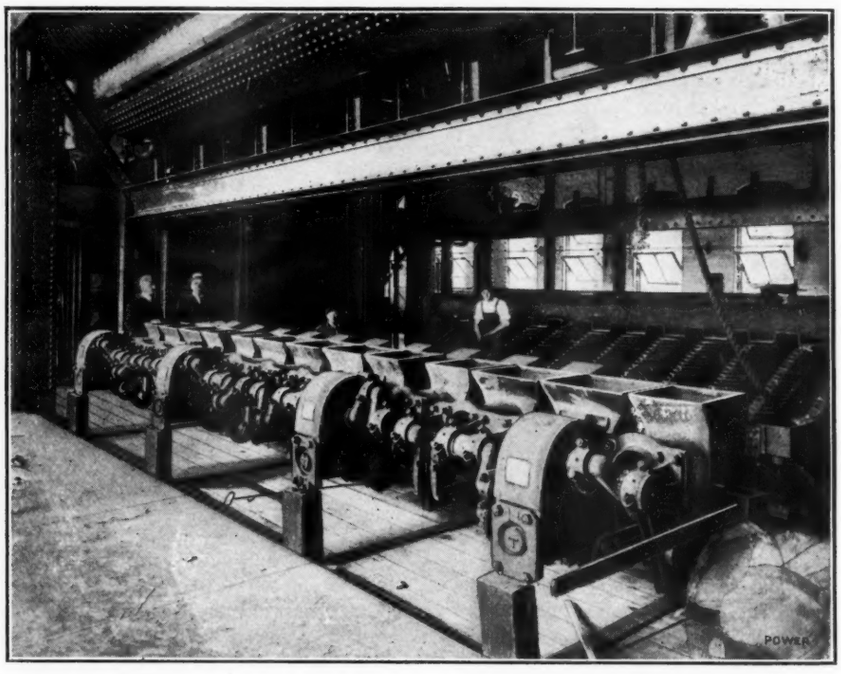


FIG. 10. TAYLOR STOKERS IN PLACE WITH BOILER FRONT REMOVED

eters and thermometers calibrated by the United States Bureau of Standards.

The disagreement in the ultimate analysis as made in the different laboratories indicates that very little confidence is to be placed in the heating values calculated from this analysis. The true heat value should be known.

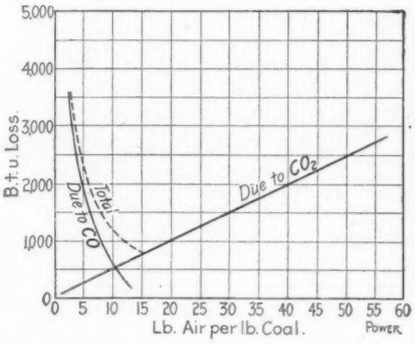


FIG. 11. RELATION BETWEEN AIR SUPPLY AND THERMAL LOSS

W. F. M. Goss, dean of the University of Illinois, said that the relation between the evaporative efficiency and the rate of power developed was one which he had studied with care in its application to locomotive boilers. The decrease in efficiency accompanying an increased rate of driving is not only relatively less than that observed in boilers with which he is familiar, but is actually very small. This fact suggests the practicability of developing the type of boiler under consideration, for work at even higher rates than has yet been attempted. It appears probable that by increasing the grate area or by altering the rate of combustion, this type of boiler may be made to evaporate 10 or 12 lb. of water per square foot of heating surface per hour, with an efficiency which will be well above 70 per cent.

E. P. Dreyfus, of the Westinghouse Machine Co., recalled that the 10,000-kw. turbine unit, described in the last issue of the society's *Transactions*, required 17,250 B.t.u. per kilowatt-hour at three-quarters load with a boiler efficiency of 75 per cent., the combined results, including boiler losses, being 22,000 B.t.u. In large plants using steam-driven auxiliaries with their exhaust returned to the boiler, the increased consumption which they occasion is well within 5 per cent. He believed it safe to say that such a plant would run on 24,000 B.t.u., or 2 lb. of coal per kilowatt-hour.

Prof. R. C. Carpenter, of Cornell University, said that the high results were entirely due to the method by which the furnace was handled, to the very high grade of coal used and to the remarkable control of the air supply. The results of the flue-gas analyses in all these tests show that they were run at just about the limit of CO_2.

FIG. 13. FALLEN ARCH

John C. Parker, of the Parker Boiler Co., compared the present tests with those made by H. F. Stott at the Fifty-ninth St. station of the Interborough Rapid Transit Co., and reported to the American Institute of Electrical Engineers four years ago. Taking the highest test with the Taylor stoker and with nearly forty pounds of coal per square foot of grate, Mr. Stott would have had to increase his combustion efficiency 42 per cent. to equal the results obtained at Detroit.

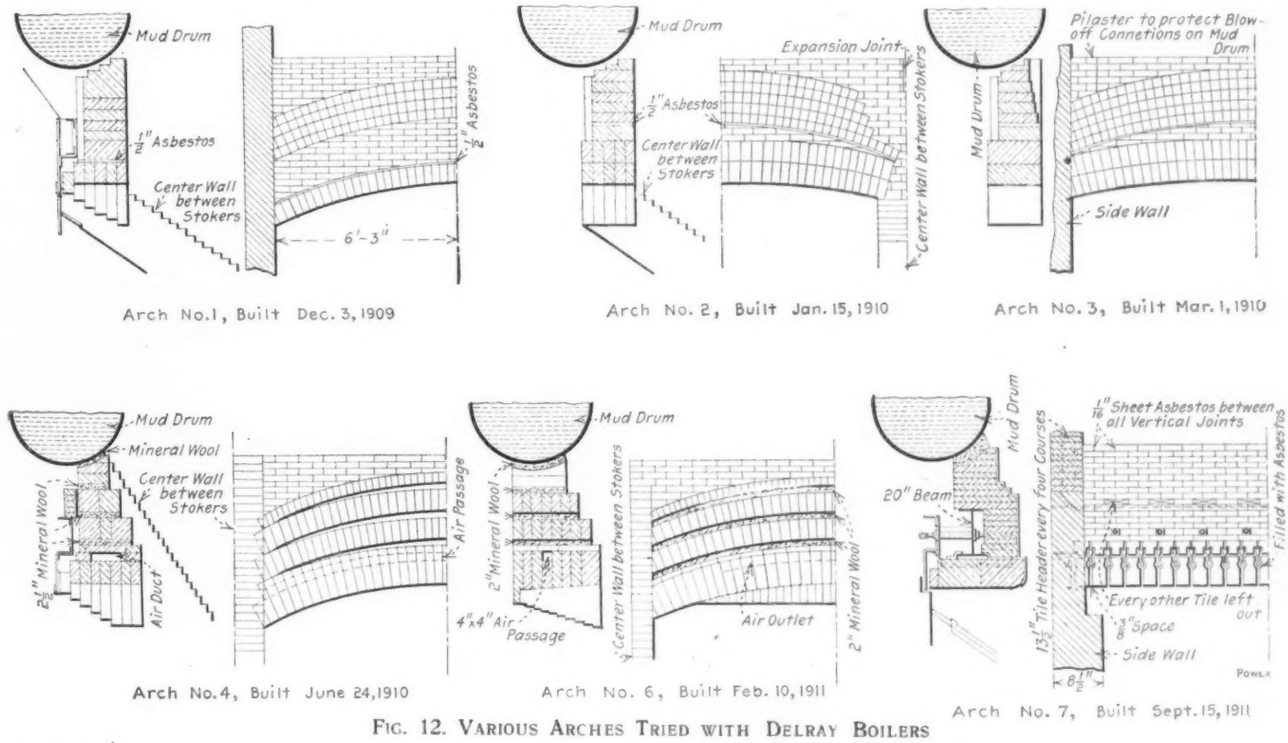

Mud Drum
1/2" Asbestos
Center Wall between Stokers
6'-3"
Arch No.1, Built Dec. 3, 1909
Expansion Joint
Center Wall between Stokers
Arch No. 2, Built Jan. 15, 1910
Pilaster to protect Blow-off Connections on Mud Drum
Side Wall
Arch No. 3, Built Mar. 1, 1910
Mineral Wool
Air Duct
Air Passage
Arch No. 4, Built June 24, 1910
4"x4" Air Passage
Air Outlet
Arch No. 6, Built Feb. 10, 1911
20" Beam
1/16" Sheet Asbestos between all Vertical Joints
Every other Tile left out
3" Space
Side Wall
Arch No. 7, Built Sept. 15, 1911

FIG. 12. VARIOUS ARCHES TRIED WITH DELRAY BOILERS

Fuel Economies in Factories*

By Dr. Charles E. Lucke†

The author compares the advantages offered by steam and producer gas for the four uses for which heat is employed in industrial establishments: Power, heating, lighting and industrial processes; and finds a substantial balance in favor of the gas system when mantle light for weak gas and gas fired evaporators, concentrators, cookers, etc., shall be available.

*Abstract of paper presented to the New York section of the American Chemical Society.

†Professor of mechanical engineering at Columbia University.

In conducting the financial operations of a business, no one would think for a moment of dispensing with records of expenditures and income or would fail to provide a more or less elaborate cost system for distributing the expense over the various parts of the apparatus used in production and for dividing the cost of the products into the different elements that make it up. Cost information is worth as much as the possible saving in cost of production to which the information leads.

Necessity for Heat Accounting

There can be no rational attempt made toward fuel economy in a given system of manufacture using fuel, without a knowledge of the distribution of the heat of that fuel, though it is quite possible that the information may not be of sufficient value to warrant as complete a distribution of the expense of heat supply or as elaborate a system of records as would be warranted in the case of labor or materials entering directly into the factory product. However, there can be no question as to the absolute necessity for some heat accounting to determine the coal-heat charge to be attached to each individual process using heat and to show sources and quantities of utilizable waste heat, however simple the system of the accounting may be, nor can there be any doubt as to the increasing justification for more and more elaborate records as coal cost forms an increasing fraction of the total cost of production.

Four Classes of Service

It may be assumed that in a factory fuel enters directly or indirectly into four classes of services, all of which are essential to the making of the product, namely, power; factory heating in cold weather; factory lighting, and direct manufacturing processes, as heating, cooling, evaporating, condensing, melting and drying.

The primary process in the use of heat is the making of steam on the one hand or the gasifying of coal on the other, and the direct loss encountered in either of these processes is the first factor for measurement and record in the heat-accounting system. This first step of conversion may be had with an average efficiency of 65 to 75 per cent. for the steam system, depending on the coal, proper firing and the type of equipment; and an efficiency of from 75 to 85 per cent. for the gas system, showing a clear gain of about 10 per cent. for the gas system on the average for this first step, with, however, a limitation. This limitation is the inability of the producer to handle as wide a range of fuel with equal success to that attainable in the boiler.

Steam once made is transmitted in pipes for short distances only, and under high pressure, with a constant heat loss for every foot and involving high maintenance charges, on its way to engines for shaft power or electrical generation. Gas, however, may be transmitted at low pressure over long distances to all the buildings of large establishments or to neighboring establishments or from a central gas-generating station dozens of miles distant through pipes, and transmitted cheaper than those required for steam and with almost no maintenance cost in comparison. This pipe-distribution cost is the next item in the accounting and, without setting down numerical values, is again plainly in favor of the gas system; it involves no heat loss whatsoever while the steam involves a large one and the pipe-maintenance costs are hardly comparable.

The next step is the conversion into work in the engine of the heat carried by either the gas or the steam. Here the balance is again in favor of gas as the gas engine is a more efficient heat converter than the steam engine in the small sizes found in the average factory —and even in larger sizes also, though to a lesser degree. Few factories would find occasion to use engine units exceeding 1000 horsepower, which size, operated condensing, whether of the turbine or compound Corliss type, will yield thermal efficiencies less than 20 per cent., whereas if operated noncondensing these efficiencies would drop to at least 15 per cent.

A smaller steam-engine size of, say, 100 horsepower, will be less efficient and the turbine would not be so good as the piston type, though the difference would not be so great. For this size the dependable efficiency would be about 15 per cent. when operated condensing and not over 10 per cent. when operated noncondensing. A comparison of these efficiencies with the substantially constant thermal efficiency for the gas engine in all sizes, of 25 per cent., will indicate a margin in favor of the gas of at least 5 per cent. over large steam engines condensing, 10 per cent. over the smaller condensing and the large noncondensing, and 15 per cent. over the small noncondensing steam engines.

If electricity is generated and transmitted for lighting or for use in electric motors, the efficiency of electrical generation, transmission and reconversion to power and light is the same for both systems.

Economy of Individual Gas Engines

Another item not generally or sufficiently appreciated may be put on the credit side of the account in favor of gas and that is to set down small individual gas engines at the spot where power is required and transmit gas with practically no loss instead of generating electricity and transmitting it to electric motors with three losses. This would not only save the expense of the electrical equipment but would save all electrical losses, which are often considerable when the generator and the motor work at unfavorable loads. This is feasible and will give substantially the same efficiency of conversion as is obtainable in a single large central engine, a fact which especially distinguishes the gas from the steam system.

Concentration of small steam engines into a single large one always results in steam economy, a fact which has led to constant concentration of steam systems into larger and larger central generating units, so that steam may be regarded as a centralizing influence. The constancy of gas-engine efficiencies, on the contrary, in large or small sizes, must characterize the gas system as a decentralizing influence in the interests of economy.

Factory Lighting

Take next the question of factory lighting, which may be electrical, with current supplied by either steam- or gas-driven generators, and which can be only electrical for steam-engine driven generators but may be something else when gas is available. There is no good reason for assuming that mantle lights of fair brilliance and moderate gas con-

sumption cannot be produced to operate on weak producer gas for factory lighting and as soon as they become available—as they surely will when the demand becomes pressing enough—mantle gas lighting with producer gas will displace to a very large extent electric lighting in those establishments where the gas system is used for power and heat and gas transmission is substituted, at least in part, for electric.

Factory Heating

Heating of buildings is almost universally accomplished by means of steam- or water-heated radiating surfaces at a temperature of about 200 degrees Fahrenheit, and there is no good reason for changing the system. The preparation of this low-pressure steam or moderately high water can be done with equal efficiency by either the gas or the steam system in cold weather, though the latter again receives a credit charge for all the rest of the year when heat is not required.

For example, if the exhaust steam from steam engines is used it must be at approximately atmospheric pressure to give a sufficiently high temperature, or live steam must be used either alone or added through reducing valves as make-up. In any case, the heat put into the heating system gives about 100 per cent. effect in the warming of buildings, especially when drips are returned. This is also the case for the gas system as jacket-water heat and exhaust-gas heat can be combined for the same purpose and fresh gas drawn upon through thermostatic gas burners to supply any deficiency.

By either method the effect is a full use of heat and 100 per cent. efficiency in the use of fresh supplies of heat in the warming of the building. During the time there is no building heat, which in New York City lasts for more than half the year, the waste heat of the steam engine is far in excess of that of the gas engines, especially if the former be noncondensing, as is usually the case where exhaust-steam heating systems are employed, so that, measured over the whole year, the gas system is again most favored.

Heat for Manufacturing Processes

There remains now to examine the possibilities of credit or debit items for the two systems in applying the heat to the direct manufacturing processes, which for convenience may be divided into low-temperature heating and high-temperature heating; the former includes most of the evaporating and drying processes and the latter the roasting, baking, melting, etc. All low-temperature processes can be carried on by steam-jacketed chambers or by steam-coil apparatus using live or exhaust steam, a fact which has led to the design and mechanical perfection of many appliances now regarded as standard and for which there is no gas-heated equivalent.

There is no good reason why equivalent apparatus should not be quite as effectively designed, and with efficiencies over 90 per cent. for operation with gas burners, but, like the mantle light, the need is not strong enough to warrant their production. Such evaporators, concentrators, cookers and driers as fall in this class will, when gas heated, offer still further simplification of piping and reduction of piping loss over their steam-heated equivalents and should be equally effective.

High-temperature heating can be accomplished only by oil, piped illuminating gas or by independent coal fire with the steam factory system, while the gas system offers a possibility of the producer gas-fired furnace for practically all services, and with almost perfect temperature control, better by far than is possible with oil or coal, and it is more economical because both excess air and incomplete combustion can be eliminated.

Thus, for the heating processes of manufacture the gas system offers the same high-temperature source of heat, a gas fire, for all, while the steam system requires fresh fuel for the high temperatures, accomplishing the low-temperature service with live or exhaust steam; the former is not an accomplished fact simply because no one is yet prepared to sell gas-fired appliances to take the place of steam-heated ones.

Gas and Steam Systems Compared

Comparing gas and steam systems broadly by summarizing the preceding brief analysis, it appears that the self-contained factory plant may be much more economically operated by the former than by the latter for all the services of power, lighting, building and process heating. This is not all, for there is also in favor of the gas a simplicity in the heat-balance determination for the gas over the steam so great as to make it easier to keep the operating economy nearer to the high possibility by quick and easy determination of wastes.

For example, by means of a central gas meter and as many individual distributing meters as the separate consumptions of gas, the gas generated may be easily known, as well as its distribution throughout the plant, by so simple a procedure as the reading of meter dials. Add to this recording calorimeters, and gas-meter readings can be reduced by one multiplication to heat consumed by each part of the system. With such a ready check on consumptions and losses, it is sure that heat accounting will be practised because the cost of the account will be small; therefore, the plant may be operated at somewhere near its good economy point.

This is in most striking contrast to the case of the steam system, where the possible economy is not only less but where the realized economy is so much below its own maximum possibility simply because of the difficulty of making the measurements necessary to a heat balance with reasonable accounting costs. In the first place, it is impossible to continuously measure the heat supplied in steam because there is no reliable and cheap steam meter available; even if there were, the heat equivalent of a pound of steam constantly varies with feed-temperature steam, pressure and its wetness or superheat.

Pipe-line losses can be determined only by collecting and weighing drips; steam consumption of the various appliances and its heat equivalent are a matter of recording meters, steam calorimeters, thermometers, pressure gages and automatic water weighers. To keep up all the instruments of this sort that would be needed would in most cases cost more than the information would be worth.

Why is it, in view of both the higher possible economies of the self-contained gas-factory system for the four classes of factory service and the correspondingly easier and cheaper fuel accounting that would follow its use, that there is to be found no such system in use? The answer is as complex as a detailed study of the systems, but a few facts stand out prominently. First, the inertia of the human mind, which resists the mental effort necessary to bring about a change when things seem to be running fairly well in the older way. There is always a latent suspicion that the new thing may not work, however clear it is, put on paper, and even if the manager is convinced, his board of directors are ordinarily incapable of thinking of anything but the factory's past performance, however willing they may be to deal in the fixtures of stocks and bonds.

So far in this particular case there has been some good reason for suspicion, not of the scientific and engineering possibilities, but of the business expediency of a general change because of the lack of standardization or mechanical perfection of some of the needed appliances. There are no producer-gas mantles for lighting, no gas-fired evaporators, concentrators or driers, and, most important of all, there is no universal gas producer capable of economically using any available solid fuel.

The gas-appliance makers should get to work on the problem of adapting apparatus for all the manifold services of lighting and heating to the use of weak producer gas and chemists and engineers should try to solve the gas-producer problem.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Repairing Induction Motor Winding

By R. H. Fenkhausen

Rewinding Stators

The simplest form of stator coil and the one in most common use by builders of motors for industrial service is known as the diamond-shaped coil. The present article describes the operations required in the winding of a set of these coils. Before taking up the various processes in detail, I think it advisable to describe briefly a few of the more important factors governing the shape of this type of coil, for the benefit of the repair man who may be called upon to design a form for the coils without the assistance afforded by a sample coil. Of course, it seldom occurs that a winding is so completely destroyed that the original coil shape cannot be determined, but occasionally the winding is removed by a helper who neglects his instructions to preserve the shape of one coil, leaving the repair man no information other than the size of wire and number of turns.

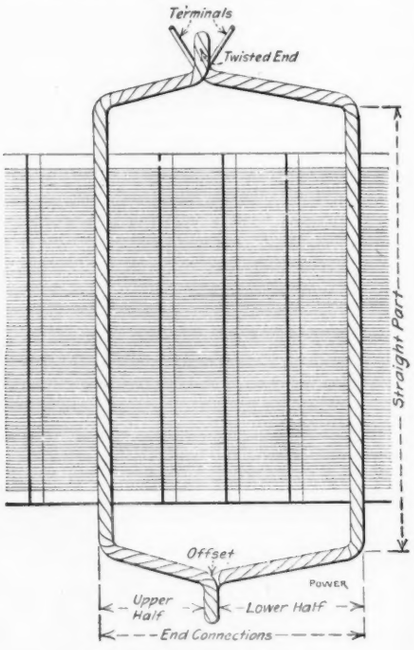


Fig. 1. A Diamond Coil

Fig. 1 shows a diamond-shaped coil with the different parts named and Fig. 2 two coils in place on the stator of a motor, illustrating how each coil occupies the lower half of one slot and the upper half of another several slots away. The magnetizing power of a coil is directly proportional to the current it "carries" and the number of turns it contains, and is independent of the length of turn. It therefore follows that the shorter the turns the less copper will be required, and consequently the lower the resistance and less the loss in the winding. An inspection of Fig. 1 shows that the coil is a great deal longer than is necessary to inclose the iron, but this excess length is required in order that all the coils of the set may clear one another. The part of the coil lying outside the slot is practically idle wire, and is known as the "end connections." This term must not be confused with the "cross-connections" between different groups of coils and the different coils of one group.

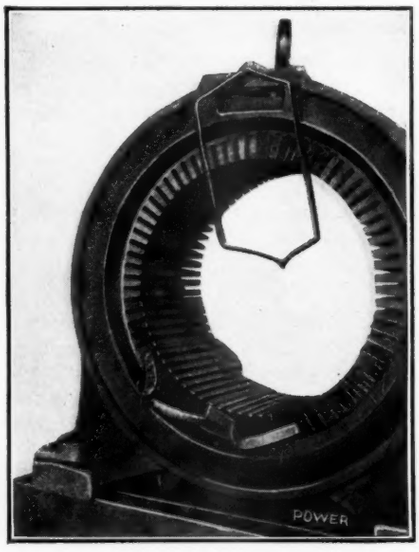


Fig. 2. Two Coils in Position

Coil Pitch

The length of the end connection is largely governed by the number of teeth spanned by the coil. This is called the "pitch" of the coil. The "full" pitch is equal to the number of teeth in the stator divided by the number of poles. In practice, however, the coil pitch is usually less than the "full" pitch; such a pitch is called a "fractional" pitch. For example: The stator shown in Fig. 2 has 72 slots and teeth and is wound for six poles. The full pitch, therefore, is $\frac{72}{6} = 12$, and a full-pitch coil would span 12 teeth, lying in slots 1 and 13. The coils shown only span eight teeth and lie in slots Nos. 1 and 9, which is only two-thirds of the full pitch.

The fractional pitch has the disadvantage that the magnetizing current required with a given number of turns is greater than it would be with full pitch. This increase, however, is not proportional to the decrease in pitch; a two-thirds pitch, as shown in Fig. 2, only results in a comparatively small increase in magnetizing current.

The disadvantage just mentioned is over-balanced many times by the numerous advantages obtained by the use of a fractional pitch. The more important advantages are as follows:

(1) Ease of repair owing to the smaller number of coils which must be raised to permit a defective coil to be removed for repairs. This advantage is especially marked in high-speed or low-frequency motors having few poles and consequently large coil pitches.

(2) Better ventilation, owing to the air space left between the end connections. If the distance *E*, Fig. 3, be kept

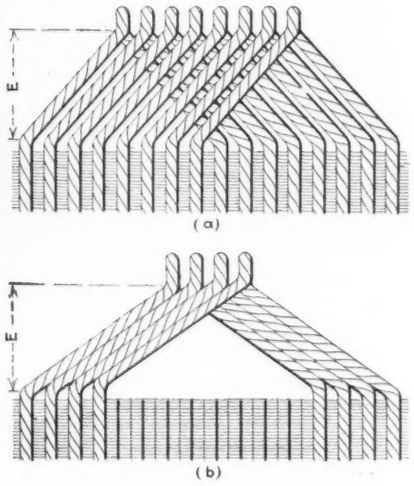


Fig. 3. Effect of Coil Pitch on Angularity of Ends

the same, the angle formed by the end connections will be more acute with the fractional pitch, as at *a*, than with the full pitch, as at *b*, and therefore the coils will be separated by an air space as shown.

(3) Less insulation is required on the end connections, owing to the pressure of the air space previously mentioned.

(4) Less copper is required, owing to the decreased length of end connections.

(5) Improved efficiency of the motor due to the decrease in copper and hence in the resistance loss in the winding. This will usually counter-balance the increased magnetizing current required.

(6) In practice the distance E (Fig. 3) to which the coils project beyond the core will be decreased, because the gain in space between coils will be greater than is necessary for adequate ventilation and insulation. By making E less, the end connections and copper loss are further decreased.

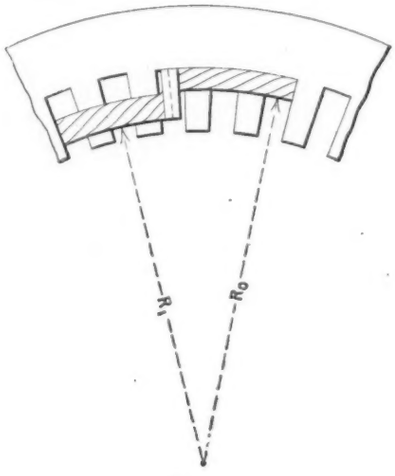


FIG. 4

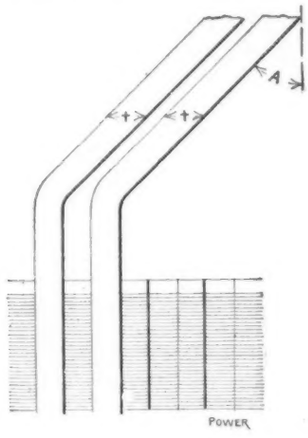


FIG. 5

(7) Shortening that part of the coil which projects beyond the core renders the end connections less liable to damage by magnetic reactions such as are caused by severe short-circuits or heavy overloads, and the entire motor may be made shorter, resulting in a saving of material.

SHAPE OF END CONNECTIONS

The diamond-coil winding is in effect a two-layer winding, as the lower "sides" of the coils form one layer and the upper "sides" another. As the thickness of the coils is the same in both cases, a little consideration will show that the air space between the coil sides lying in the tops of the slots is less than that between the coil sides in the bottoms of the slots, which lie on a circle of larger diameter. The angular distance between the sides or straight parts of the coils must, of course, always equal the thickness of the teeth but the space between the end connections is governed by the angle which they form. The more acute this angle is, the more space there is between coils.

The factors affected by this angle were fully discussed with fractional pitch and should be carefully noted before deciding on the angle to be used. The circumference of the inner diameter of each layer of coils (radii R_1 and R_0, Fig. 4) should be measured and divided by the total number of coils. The coil angle which it is proposed to use should then be laid out to scale accurately, as shown in Fig. 5, and the distance t determined by measurement. If this distance is less than the number obtained by dividing the circumference by the number of coils, there will be a space between the end connections equal to the difference between the two measurements. If the distance t is greater, however, the angle A must be made more acute, because the coils cannot be placed in the slots with the end connections side by side; they will pile up on one another. If the angle A is such that there will be space between the coil sides in the inner layer (smaller circle) there will be a slightly larger space between the coil sides of the outer layer, but as a rule this difference is so slight as to be negligible.

On stators of small diameter and few poles, however, the difference between the diameters of the inner and outer coil circles is a large enough proportion of the stator diameter to render it impossible to design a coil having the same angle of end connections in both layers, especially when the long pitch due to the few poles is considered. In such cases it becomes necessary to calculate the angle for each layer separately, and an unsymmetrical coil results; this is no disadvantage for a form-wound coil, however.

LENGTH OF COIL SIDES

The two straight portions of each coil lying inside the slots, called the "sides," are usually made of the same length, but the coils will fall into place more easily if the inner "side" (the one which is put in the slot last) is made longer than the other "side" by an amount equal to twice the thickness t (Fig. 5). This will allow the last few coils of the winding, which always are the most troublesome, to be inserted much more easily, because the under "side" of the coil will pass under and through the upper "sides" of the other coils without raising them out of the slots any more than enough to clear the height of the coil.

MAKING THE FORM

A consideration of the preceding explanations should enable the reader to decide on the exact coil proportions required, and even if a sample coil be at hand for a guide, it will be to the reader's advantage to check up his coil for the sake of future jobs when he may not be so fortunate.

The laying out of a diamond coil appears very simple and it was once the writer's misfortune to lay out a form with this delusion in mind, resulting in a beautiful-looking set of coils which, alas, went into the scrap copper box because they would fit nowhere else, owing to the hastily designed end connections.

The form must be made of some hard, non-warping wood, preferably teak. Lignum vitæ is also excellent, but, owing to the cost of working it, should not be used except for a form likely to receive a great deal of use. Two pieces of wood will be required, each about ⅛ in. thicker than the height of the coil and as wide as its extreme width. The length

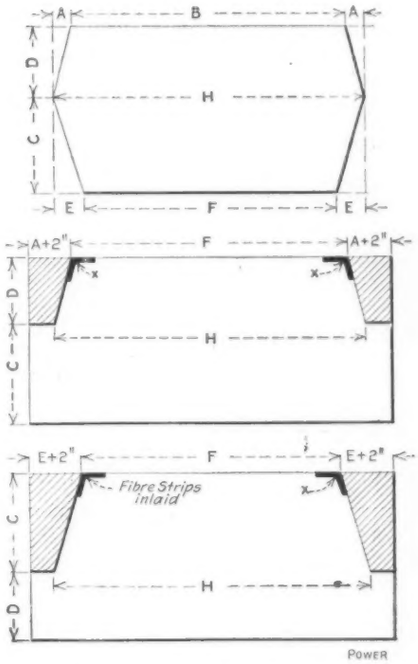


FIG. 6. LAYING OUT COIL FORM

must exceed the extreme length of the coil by about an inch, all dimensions being taken with the coil flattened out.

The pieces of wood must be surfaced off perfectly true and parallel on the edges, after which the exact dimensions of the coil must be laid out on them with a sharp pencil, as shown in Fig. 6, which also shows the pieces to be cut out of the corners. The form may then be cut out, preferably on a band saw, to insure square edges, and the pieces sawed out

must be preserved, as they may be required later. All edges of the form must be sandpapered dead smooth and the corners at *X, X* in Fig. 6 slightly rounded to prevent damage to the cotton covering on the wire. As the wire tends to sink into the wood at these corners, due to the tension employed in winding, the shape of the form will be gradually changed; therefore, when the number of coils to be made will warrant the additional expense, pieces of fiber should be inserted at these points, as shown in Fig. 6.

Producing the Coil Offset

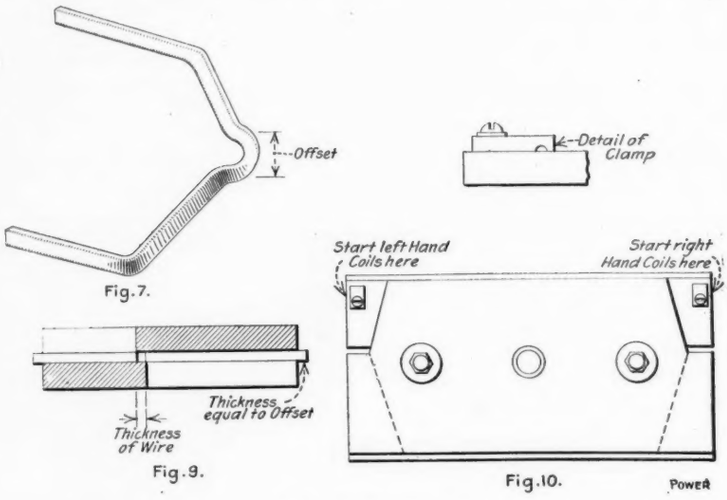
When the coils are in place in the motor it is desirable that there be an air space between the top and bottom layers of end connections for ventilation and improved insulation where the coils cross each other. This air space is obtained by giving an offset to the twists in the end connections; this offset is shown in Fig. 7; it is obtained by inserting a piece of fiber between the two halves of the form. The thickness of this sheet of fiber ranges from ⅛ in. for the coil of a 2-hp. motor to ⅜ in. for a coil for a 50-hp. motor, ¼ in. being a good average for motors of 5 to 20 horsepower.

In order that the coil may be removed from the form it is necessary that the fiber sheet be in halves, and each half attached to half of the form, as shown in Fig. 8. The sheet should be cut to the same length as the form but should exceed the width of the form by about ½ in. in order that a small ledge will be formed on which the coil may be wound. The form must next be lined up so that the edges will stand open enough to admit the wire to be used, as shown in Fig. 9, and firmly clamped in this position at both ends.

Bushings, Etc.

The form must be held together by two ½-in. bolts closely fitting the holes drilled for the purpose, and as more or less hammering will be necessary during the subsequent winding and shaping of the coils, it is advisable to drill the holes large enough to take bushings made of brass tubing of ½ in. inside diameter. These bushings must be a tight fit in one half of the form and a close sliding fit in the other half. A third bushing should be inserted at the exact center of gravity of the form to serve as a bearing for the mandrel upon which it will revolve during the winding of the coil.

Two hacksaw cuts must be made on each side of the form about ¼ in. from the ends of the straight parts of the coil. These sawcuts are to permit the binding wires, which hold the coil in shape after its removal from the form, to be inserted under the wire.



Figs. 7, 9 and 10

A small fiber clamp held by a wood screw and copper burr must be attached to the form to hold the beginning end of the wire in each coil. This clamp must be on the end of the form corresponding to the terminal end of the coil, and where right- and left-hand coils are used in the same motor the clamp must be transferred to the opposite end, after half the number of coils is wound, as shown in Fig. 10.

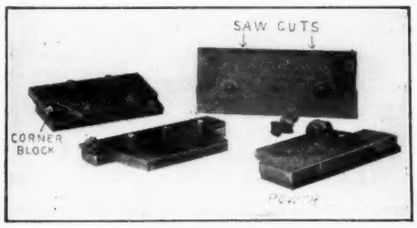


Fig. 8. Coil Forms

When the coils are symmetrical, it is immaterial to which side of the form the clamp is attached, but when an unsymmetrical coil is to be wound the clamp must be fastened to the side of the form having the longest straight portion or coil "side."

The *end* to which the clamp is fastened determines the "hand" of the coil, the *side* to which it is fastened governs the location of the splice between elements of a coil, as will be described later.

The bushings, sawcuts, clamp and other details are clearly shown in Fig. 8, a close examination of which is advisable before proceeding to make a form.

Use of Corner Blocks

The small form shown at the rear left of Fig. 8 is fitted with small corner blocks at each end which are missing in the other forms shown. These blocks may be made out of the pieces sawed out of the corners of the form, which were put aside, and their use will greatly facilitate the winding of small coils having relatively many turns of fine wire.

The use of corner blocks is recommended for all forms using wire smaller than No. 14 and requiring more than seven turns per layer. When heavier wire and fewer turns are required, the cotton insulation is liable to abrasion, owing to the difficulty of forcing the comparatively stiff wire into the narrow slots between the form and the corner blocks.

As the corner blocks give the proper twist to the V-shaped ends of the coil, their omission necessitates the formation of this twist by other means. The simplest method is to wind the coil rather loosely and press each turn into approximate shape at the twist with the thumb. After all the turns are on the form the accumulated slack may be worked toward the ends of the coil by means of a small fiber block and a mallet.

Beginning at the middle of the coil "sides" and working toward the ends the coil is gently driven into shape against the edges of the form. After one or two practice coils have been wound, the proper tension to give during the winding operation will be determined easily, and once the knack is caught it will be found that twice as many coils can be wound in a given time without corner blocks as with them.

"To a large extent," said Frank W. Smith, secretary of the United Electric Light & Power Co., of New York City, "the prosperity that you and I enjoy is due to the passing of individualism and to the present-day spirit of coöperation. Without organization, the best effort is not possible of attainment. It means betterment for you individually and collectively; it means improved conditions, greater success and a sure future for your company; for, without a loyal force 'laboring together with others for a common end,' great success and prosperity to any business enterprise must fail."

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

A German Peat Gas Power Plant

By Paul C. Percy

At the East German Exhibition which was held some time ago at Posen, a complete peat-gas power plant in full operation attracted a great deal of attention. The producer was the Heinz apparatus, described last June in POWER, and the engine was a horizontal single-cylinder, double-acting machine, designed especially to work on the variable quality of gas characteristic of peat gasification.

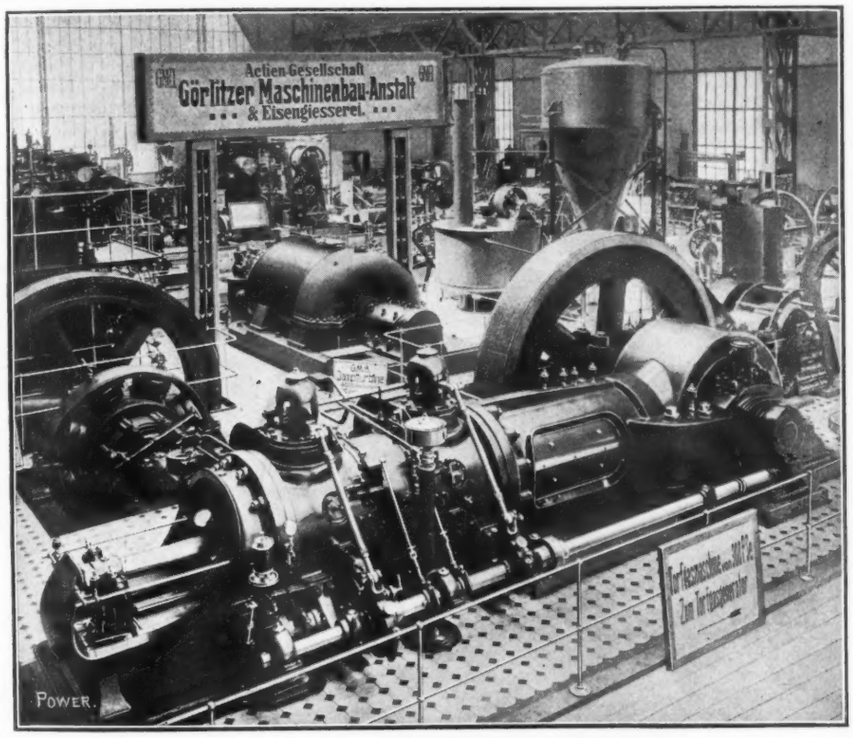


FIG. 1. GORLITZER 300-HP. PEAT-GAS ENGINE

Fig. 1 is a view of the engine in the exhibition hall. As the picture clearly indicates, the engine is very "stockily" built. This construction, together with a relatively moderate compression pressure, is employed in order that, even with the high explosion pressures produced by especially "snappy" gas, the parts subjected to the explosion stresses may have a margin of safety. The inlet and exhaust valves of one end of the cylinder are operated from a single eccentric on the layshaft (the engine works on the four-stroke cycle), an arrangement now quite common. It will be noted that the American practice of using side-crank construction is followed instead of the old German center-crank form. Ignition is effected by means of the oscillating type of magneto and make-and-break igniters tripped by linkage from the magneto shafts. An individual magneto is provided for each combustion chamber.

The engine is rated at 300 hp. and was used to drive an electric generator which supplied current throughout the exhibition hall.

Fig. 2 is a sectional view of the producer outfit. The gas generator may be considered as in the down-draft class, but differs in several important respects from the ordinary down-draft type in general use. The air is taken from the pit beneath it, which also contains the scrubber water and the gas-delivery pipe *D*. Part of the air is drawn through the pipe *A* and the superheater *B* into the upper part of the fuel column, whence it must travel down through the fuel bed in order to reach the gas outlet below. The remainder of the air ascends through the space between the outer and the inner shells of the generator, absorbing radiant heat, and under normal conditions it enters, through the valve *C* at the base of the purge pipe *F*, the combustion chamber above the fuel bed.

Gasification of the fuel takes place in one direction only, and the gas is withdrawn from the center of the combustion chamber below. The air, instead of traveling along the walls of the generator, is forced to enter the inner strata of the fuel bed. The heavy gases produced in the upper layers of the fuel bed are forced to pass through the incandescent zone below, where they are

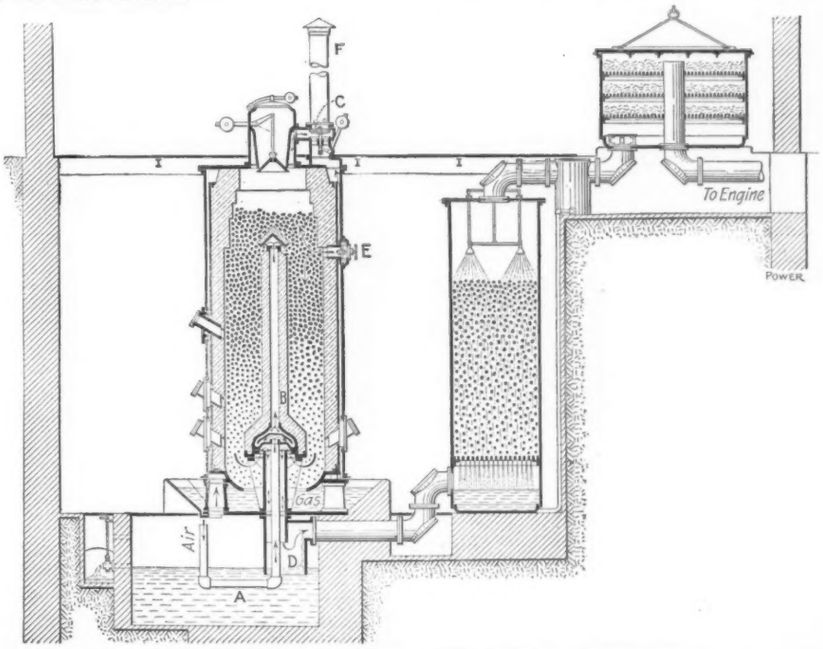


FIG. 2. SECTIONAL ELEVATION OF HEINZ PRODUCER

split up and converted into light and permanent gases.

If the water content of the peat exceeds certain limits, somewhere around 40 per cent., an auxiliary process is employed temporarily by starting a second combustion zone near the top of the fuel bed. This is done, by opening the pipe *F*

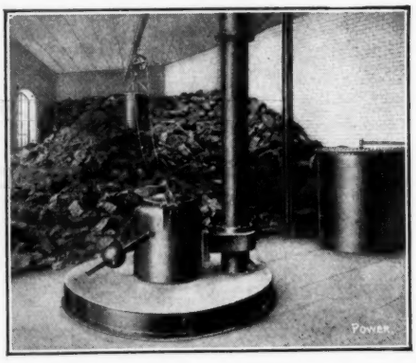


FIG. 3. THE CHARGING FLOOR

and the auxiliary air-inlet valve *E*, as soon as the attendant notes that the fire on top of the fuel column is disappearing. The valve *C* then closes automatically and the air which is preheated in the space between the shells enters the fuel bed directly through the valve *E*. Thus combustion is started at the level of *E* both ways, the up-draft being provided by the pipe *F* serving as a chimney and the down-draft by the suction of the engine. As soon as incandescence is reestablished on top of the fuel bed the purge pipe *F* is closed off and the valve *E* shut; the normal process is thereby resumed. By the temporary employment of this expedient, fuels of very high water content can be gasified. Of course, there is a moisture limit, for in peat containing 80 per cent. of water the 20 per cent. of combustible would be only sufficient to vaporize the water and no combustible gas could be produced. With the auxiliary process the consumption of fuel per horsepower-hour becomes somewhat greater than normal, but the operation is very simple and free from troubles.

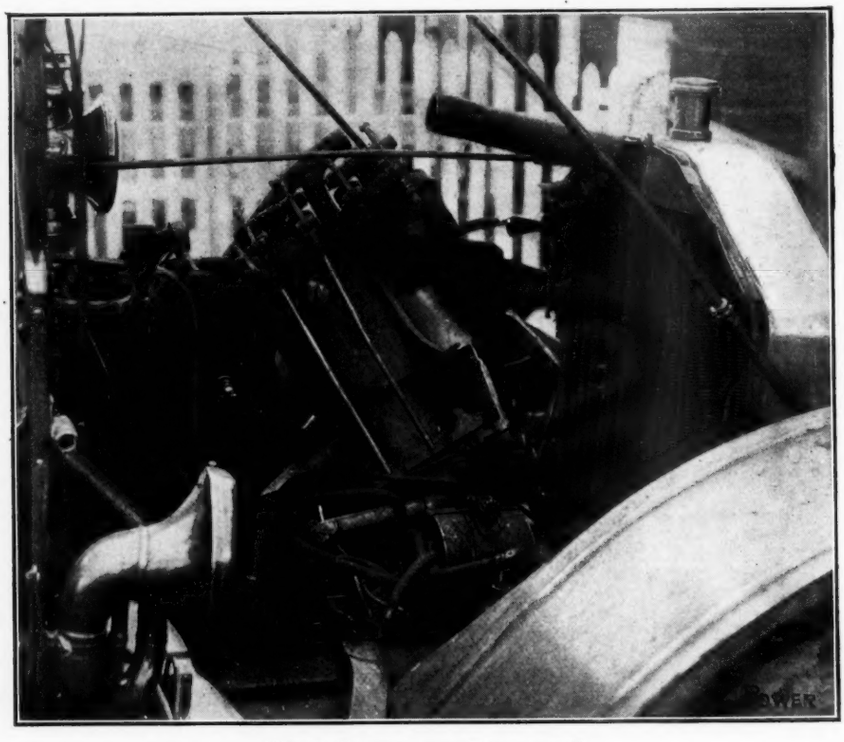
In this producer all the gases emanating from the scrubber water are drawn up with the air into the combustion chamber and destroyed. The gas produced is very clean.

Fig. 3 is a view of the charging floor of the producer exhibited at Posen. The simplicity and cleanliness are obvious from the picture. The producer and engine were built by the Görlitzer Machine Works, Görlitz, Germany.

LETTERS

What Caused the Explosion?

The accompanying picture gives a view of an automobile engine that was wrecked by the bursting of the front cylinder. This was a four-cylinder engine of about 35 hp. and had been in excellent working order. The car had not been taken out of the garage for three or four days before the explosion, and it can hardly be supposed that anyone could have tampered with the engine. As can be seen, the front cylinder is literally blown to pieces; the cylinders being cast in pairs, No. 2 cylinder was broken from the crank case. A piece of casting was blown practically through the radiator, a large piece of casting was blown through the right-hand mudguard, the wind shield was shattered, and the bottom half of the crank case was broken into a hundred or more pieces.



WHAT CAUSED THE EXPLOSION?

When the engine was started up there was no one present except the man who started it, and he was perfectly familiar with it. His only explanation of the accident is that he attempted to start the engine as usual and only made a couple of turns of the crank when the explosion occurred.

I can offer no solution of the accident, nor has anyone who has looked at the engine. I would like to have other readers give their opinions as to the cause of the explosion. The gasoline tank contained some ten or twelve gallons of gasoline when the explosion occurred, but it was not ignited. Most of the remaining gasoline was used in another four-cylinder engine without giving any indication of unusually explosive qualities, although from the results of the explosion one would think that a few sticks of dynamite had been put into the front cylinder and then fired.

L. EARLE BROWNE.

Roundup, Mont.

Was It Too Early Igniter Timing?

While operating a 10-hp. horizontal gasoline engine in Canada last summer, I had a peculiar experience. I started up the engine one morning and when it had made a few explosions and got fairly well started, turned the ignition timer to the running position, giving early ignition. When I did so the engine was practically wrecked, the base being diagonally broken on each side and two ¾-in. studs at the head end, holding the base to the sub-base, being sheared off. The crank end of the cylinder, with half of the base, was raised, thereby bending the connecting-rod and cracking a triangular piece out of the piston. The valve and igniter settings were correct; I had gone over them shortly before starting up.

Clamps were put on each side of the base, the piston inverted until a new one could be obtained, and the engine adjusted and operated a week while I was there with fairly good satisfaction.

I would like to know if any other reader has had the same experience or if anyone can account for the wreck, except by saying that the maximum explosive force occurred exactly on dead center and there was not enough momentum to carry the flywheel over, so the weakest part gave way.

R. E. WALL.

Beloit, Wis.

Refrigeration Department

Principles and operation of ice-making and refrigerating plant and machinery

Compressor Water Jackets*

By Edward N. Friedmann

It is certainly of interest to know what influence the water jacket exerts and to know the conditions under which it is most useful; also whether it were best at times not to use the jacket. What I would like to see established is some simple rules showing the operating engineer that under certain conditions it is best to run all the water he can through the jackets, and, of course, at the lowest temperature available; also, under what conditions he should stop the flow of water to the jacket.

While investigating this problem, not having access to an experimental plant, I was limited for data to the reports of tests made at the works of the York Manufacturing Co., York, Penn., and of the Eastman Kodak tests. In reading the discussions and claims of the participants in these tests, following their completion, it may be seen that the manipulation of the water jacket was one of the bones of contention, but ever since those tests, now several years ago, the matter has rested so far as data were concerned, and no additional facts have been established or published to my knowledge, and I must, therefore, confine my observations to the material then available.

While studying the data mentioned, I found that certain conditions affected the use of the water jacket differently in the single-acting and the double-acting compressor, making the influence of the water jacket favorable or unfavorable, according to circumstances.

In a double-acting compressor, during each stroke, there is suction on one side of the piston and compression on the other, while in the single-acting compressor, during the up stroke, there is suction on the bottom and compression at the top; but on the down stroke only gas passes from the under side of the piston to the top, without either suction or compression. During this down stroke, which may be called the "intermediate" stroke for want of a better expression, cooling or heating takes place according to whether the mean temperature of the jacket water is below or above the temperature of the ammonia inside of the compressor. Since there is no intermediate stroke in the double-acting compressor, no such cooling or heating can take place.

Now, if the mean temperature of the jacket water were above that of the ammonia, the result, of course, would be a rise in the temperature of the ammonia, and this, in my opinion, was the case at the Eastman Kodak test No. 3, resulting in a loss. By stopping the water circulation this loss was avoided, entirely in accordance with the result of the test for capacity.

If this line of reasoning is correct, the following rules suggest themselves:

1. Run plenty of water, at as low a temperature as available, through the water jacket, in order to maintain a low mean temperature in the jacket.

2. Since the larger the diameter of compressor the smaller the amount of inside superheat (meaning the heat imparted to the gas by the cylinder walls) the greater is the chance to heat the ammonia by the jacket water. It is at times, for instance in summer, best not to use the water jacket on large compressors, say of 18 to 24 in. in diameter, but to use liquid ammonia injection instead. In the case of smaller compressors, say 12 in. and less in diameter, I consider the water jacket a very good thing, effecting a greater cooling than is possible in the double-acting compressor not having this intermediate stroke.

As an illustration, consider the following three examples, taken from tests of a York single-acting compressor:

Test No. 1

Test made by York Manufacturing Co. on machine having two 12½x18-in. single-acting vertical compressors:

Ammonia discharge temperature, 213 deg. F.

Ammonia suction temperature, 19 deg. F.

Temperature at end of suction stroke, 72 deg. F.

Mean temperature of jacket water, 63 deg. F.

Temperature difference between jacket water and ammonia, 9 deg. F.

Inner surface of compressors and heads equals 11 sq.ft.

$$11 \times 9 = 99$$

hence the cooling accomplished during the intermediate stroke was 99 B.t.u. per minute. In this case the water jacket was beneficial to the extent indicated.

Test No. 2

Test made by York Manufacturing Co. in Rochester on machine having two 15x 22-in. single-acting vertical compressors:

Ammonia discharge temperature, 216 deg. F.

Ammonia suction temperature, 15 deg. F.

Calculated temperature at end of suction stroke, 50 deg. F.

Observed mean temperature in jacket, 68 deg. F.

Temperature difference between ammonia and jacket water, 9 deg. F.

Compressors delivered 311.4 lb. of ammonia in 15 min.

Inner surface of compressors and heads, 17 sq.ft.

$$9 \times 17 = 153 \ B.t.u.$$

per minute, which is the heat exchanged, but it may be noticed that in this case the jacket water did no cooling; on the contrary, it imparted heat, the mean temperature of the water having been higher than that of the ammonia.

Assuming the refrigeration obtainable at 500 B.t.u. per pound of ammonia, the loss equals

$$\frac{153}{500} = 0.306 \ lb.$$

per minute, or for 15 min. equals 4.59 lb.

Test No. 3

Test made by York Manufacturing Co. in Rochester on the same machine as in the second test.

Ammonia discharge temperature, 250 deg. F.

Ammonia suction temperature, 16 deg. F.

Temperature at end of suction stroke, 59 deg. F.

Water still, no circulation. Compressors delivered 315.65 lb. of ammonia per 15 min.

Adding the above 4.59 lb. to this gives 320.24 lb. The difference, which is extremely small, may be explained by the fact that in test 3 the suction temperature was higher and the suction pressure slightly lower than in test 2.

Test No. 4

Test of 21-in. single-acting York compressor at Ebling's brewery, New York City:

Ammonia discharge temperature, 279 deg. F.

Ammonia suction temperature, 6 deg. F.

Temperature at end of suction stroke, 40 deg. F.

Mean temperature of jacket water assumed at 90 deg. F.

In this case the difference between the ammonia and jacket water was

$$90 - 40 = 50 \ deg. \ F.$$

and, owing to the large surface of these compressors, the heating was consider-

*Excerpts from paper read at the New York meeting of the American Society of Refrigerating Engineers.

able, and if no water jacket had been used the test results would have proved more favorable than they did.

The conclusions I have come to are as follows: It is of great importance that these questions, as to when a water jacket is an advantage or a drawback, be settled by the manufacturers who are in position to have accurate tests made in their test plants, for it seems obvious that the construction of the compressor should be suitable for each particular case. As for practical reasons this is not feasible; the manipulation of the water jacket should be modified in accordance with the conditions met with in practice. With large compressors, say from 18 to 24 in. diameter, and where the cooling water available is of high temperature, such as 70 to 90 deg. F., which is often the case under summer conditions, the water jacket is not only of no benefit, but rather a detriment, while under the same conditions with small compressors, say from 12 in. diameter down, the water jacket will be an advantage.

It is regrettable that the tests by the manufacturers have usually been made under abnormal conditions, the cooling water being what may be termed "winter" water, while the condenser pressures were artificially made to correspond with summer conditions. Thus, the compressor is surrounded by colder water than would be the case under ordinary summer conditions, which influences both the tonnage of refrigerating capacity and horsepower; as a reduction of discharge temperature effects a corresponding reduction in horsepower, nearly all the power put into a compressor being expended in increasing the temperature of the ammonia vapor to that of the discharge.

The Gravity Feed System*

By Theodore O. Vilter

I have found in my experience in traveling around the country that a great many people believe the coils in a gravity-feed system, which is commonly but incorrectly called the flooded system, are full of anhydrous liquid ammonia. This is not true. As the ammonia boils, particles of gas are formed and they travel in a coil. With every foot of travel these particles of gas increase, so that at the end of the coil most of the pipe is filled with gas under suction pressure.

The gravity-feed system is designed for the purpose of supplying automatically each and every coil in a tank or a coil located in a chill room of a packing house or any series of coils that are of the same level, with the necessary supply of ammonia. In forcing every square inch of surface of every foot of pipe to its fullest extent, it is necessary to get the ammonia into that pipe, and this apparatus does that automatically, whereas with 12, 15, 30 or 40 coils, with a feed cock on each, the man who can regulate them satisfactorily is yet to be born. I have found this out in my practical experience in operating refrigerating and ice-making plants. The gravity-feed system in connection with the accumulator is the proper apparatus to be applied and the efficiency of the plant is increased by the use of this apparatus.

In the tank of a plate ice-making plant there are coils that have 10 in. of ice. Again, there are coils in the tank that are absolutely free from ice and as the water entering the tank on these bare coils is in all cases warmer than the ice, these pipes or coils will have to cool the water down to the ice-making temperature. Consequently, these coils require more ammonia than the others. The accumulator of the gravity-feed system accomplishes this result automatically and the engineer is not hampered by finding, when he comes on duty in the morning, that one coil has 2 in. of ice, another 3 in., and another 4 in. The ice forms absolutely uniform. In the plate ice plant this can be noticed, whereas in the coils of a can ice tank it is not apparent. This is why in a great many cases the efficiency of a can ice plant is increased by the addition of the gravity-feed system to existing coils.

When installing the gravity-feed system care should be taken that the accumulator is placed above the top of the coils so that the liquid may have sufficient head to enter the coils. The weight of the liquid will form a very low pressure in a tank where the cans are only 2 ft. deep. It is improved a bit with 300-lb. cans, and still more with 400-lb. cans, and much more when a plate ice plant has a tank 9 or 12 ft. deep.

Care must be taken that the liquid pipes run at an angle from the accumulator to the headers of the tank, and that the pipes are covered if they pass through a warm room in order that the ammonia may be kept from boiling as much as possible. The pipe is set at an angle in order to allow the gas that is liable to evaporate to pass back into the accumulator without retarding the flow of the liquid.

In a certain plant in the East equipped with a gravity-feed system, there were three ice tanks with three inlets from the same accumulator. The liquid-supply header was horizontal and in one tank to which it raised 9 in. it was possible to make but very little ice. The liquid header was in a warm room and in the hot summer days, of course, the ammonia boiled a great deal. The gas formed retarded the flow of liquid to the coils and reduced the output of ice.

*A paper read before the Practical Engineers' Association, in Houston, Tex.

A Floating Cold Storage Plant

A new venture which bids fair to revolutionize the methods of handling and marketing fish is to be tried by the Gorton-Pew Fisheries Co. The steamer "Alcona" is being equipped with a big cold-storage and freezing plant so that it may cruise about the various ports on the west and south coasts of Newfoundland, securing fish of all kinds, freezing and preserving them, and later shipping them from North Sidney. To help along the scheme, the Newfoundland government will allow all coal needed for operating the cold-storage plant to be admitted free of duty while the steamer is in Newfoundland waters.

The "Alcona" is of 1200 tons gross and has, in addition to the usual engine equipment of about 350 hp., two 30-ton absorption refrigerating machines which give a daily freezing capacity of 40,000 lb. of fish. Over 75,000 lb. can be spread over the freezing coils at one time. This unusual capacity in the refrigerating rooms is the result of supplying 30,000 linear feet of 1¼-in. pipe with calcium brine.

So far as is known, it is the only vessel afloat today in any part of the world carrying the absorption type of refrigerating machinery. By using vertical tubular generators, absorbers and condensers the equipment occupies very little space.

The plant was designed and is being installed by Mr. Palson, a builder of ice and cold-storage machinery at Gloucester, Mass., and the apparatus was built at the plant of the Robb Engineering Co., Ltd., at South Framingham, Mass.

The two stills or generators are 48 in. in diameter, with heavy cast-iron dished heads fitted with stuffing-boxes through which the pipe connections are made to the various coils within. The absorbers and condensers, also vertical, are 48 in. in diameter; each has one hundred and sixty-three 2½-in. tubes 7 ft. long. These were especially designed so that the tubes could expand at their upper ends and take care of any difference in expansion, which might occur between the tubes and the shells. The tubes are of extra-heavy gage, and because of the action of ammonia each tube was highly polished in a lathe so that the surface would be perfectly clean and make complete contact, thus avoiding the chance of any foreign matter getting between the metal surfaces, which would soon be eaten out by the ammonia. Designed for 150 lb. working pressure, these vessels were tested to 300 lb. pressure before leaving the shop.

All the ammonium sulphate used in Norway is supplied by four of the principal gas-works in that country.

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POWER

Status of the Boiler Horsepower

The boiler horsepower was originally what its name implies, the amount of steam required by a then prevalent type of engine for the development of one horsepower for one hour. Being based on transient conditions, it soon lost this connection with engine performance and became simply an arbitrary or conventional unit of boiler output. In the progress of steam engineering there has been a continual change in the relation between boiler rating and engine rating.

The function of a boiler is to absorb heat from the fire, putting it into water and making steam; therefore the unit of boiler output is essentially a thermal quantity. Taking the heat to vaporize one pound of water at 212 degrees as a sort of larger heat unit, the boiler horsepower is equivalent to 34.5 of these units, or to about 33,460 B.t.u. per hour.

Twenty years ago the best pumping engines were cutting their heat-input requirement to less than 14,000 B.t.u. per horsepower-hour; now they run below 12,000. Since the year 1900 there have been many records of engines in power service working within this same range of heat supply. In the design of a big plant, a boiler rating equal to half the engine rating has long been considered ample, giving margin for a reasonable layoff of boilers for cleaning and repair. The best records from big steam turbines show a consumption of only about 11,000 B.t.u. per estimated indicated horsepower-hour, so that one American boiler horsepower can produce three engine horsepower or nearly two kilowatts of electrical output.

Besides this lowering of heat required by the machine, there has been a decrease in the boiler surface considered necessary for a given heat transfer. The common allowance of ten square feet to the horsepower implies an average transfer rate of about 3350 B.t.u. per square foot per hour. Locomotive boilers commonly work at around sixty-five per cent. efficiency when conducting 5000 B.t.u. per hour, and are often pushed to as much as 12,000 or even 15,000 B.t.u., although the efficiency then falls to the neighborhood of forty-five per cent.

There is now a strong tendency to burn more coal under stationary boilers and get a bigger capacity, and experience has shown that the drop in efficiency is small. The installation of additional furnaces under the boilers at the Interborough power house several years ago was a pioneer example. The Detroit tests, recently reported to the American Society of Mechanical Engineers and published in our issue of Dec. 5, are another striking illustration. In these tests the rate of heat transfer varied from 3400 B.t.u. at eighty per cent. efficiency to 6700 at seventy-six per cent. This means that with big boilers and turbines good economy can be maintained when three square feet of heating surface are carrying one kilowatt of generator output. It is a long step from a 300-horsepower battery of boilers with a 300-horsepower engine to one boiler of 2400 horsepower rating which carries 8000 kilowatts.

The Value of Compression

As an interesting research for schools with steam-engineering laboratories, we suggest a series of tests to determine the effect of compression upon the steam consumption of an engine.

It is not a new subject. Extremely painstaking work was done upon it at Liége by Prof. Dwelshauvers-Dery, years ago (see POWER of June 28, 1910), and other tests and discussions have been published. But it is impossible from any data of which we know to draw efficiency curves of the same engine with different ratios of compression. When the compression is changed, either the load or the ratio of expansion changes at the same time, and the effect may not be due entirely to the change of compression.

It would be very illuminating if a series of tests could be made with an engine the valves of which were set for no compression, determining the steam

consumption of various loads per indicated and per brake horsepower, and with no variable but the load. Let these be plotted in the usual efficiency curves with the Willans line of total steam consumption added.

Let this series of tests be repeated for various degrees of compression, with the same pressure and quality of steam, the same speed; in fact, with all conditions as nearly as possible reproduced.

Will the efficiency curve with the greater degrees of compression lie above or below that with none?

Will they parallel or cross it?

Will the Willans line change its angle, and especially will it come nearer to the intersection of the coördinates, indicating diminished internal losses?

How will the ratio of the brake to the indicated horsepower be affected? This might be studied in connection with inertia-pressure diagrams, showing the effect of various degrees of compression upon the bearing pressure and friction.

Will some of our laboratories which are looking for directions in which to direct their activities consider the suggestion?

Misuse of the Term "Rotary" Engine

Of recent years, since the commencement of the now quite general adoption of the aëroplane by the more daring of our wealthy young men, several so called rotary engines have been evolved which may be said to be quite satisfactory, as far as that adjective can be applied to present-day aëroplane engineering. The majority of these engines are of the Gnome type, but whether they justify the use of the qualification rotary is open to serious question.

This is not such a silly-season sort of topic as it may appear to be at first blush. Aëronautics is a new science. Then let it take lessons from the older sciences and be careful how it picks its technical terms and expressions. An ill applied term once adopted and standardized by continuous use can be effaced and replaced only by superhuman efforts on the part of the heads of the profession. Endless misunderstanding and misconception were caused by the first definition of "boiler efficiency" in steam engineering. This term was made to take into account the furnace, the grate, the quality of fuel, etc., and it embraces all these factors when referred to now. Obviously, if "boiler efficiency" were what the two words plainly indicate, it would deal only with the capacity of the boiler itself to absorb heat and transfer it to the water within it, varying only with the design as regards construction, materials, heating surfaces, thickness of plates and other factors. Numberless other examples could be given of similar cases in which the loose application and misuse of a term at the beginning of a new science has stuck, to be misunderstood by each successive generation of students. It would be a pity if the future students of aëronautics should be hampered by the adoption of misnomers.

A lexicographer defines reciprocating engine as "the common form of engine, in which the piston and piston rod move backward and forward in a straight line, absolutely or relatively to the cylinder, as in oscillating engines. The term is used in contradistinction to rotary engine," which is found to be "a form of steam engine in which the piston rotates in the cylinder or the cylinder upon the piston. The varieties are numerous, but in practice rotary engines are not found to be any more economical than the reciprocating engine with crank attached." The latter part of this definition certainly presupposes the absence of cranks in rotary engines. Equally certainly, this definition was written in the days before the reign of the steam turbine and equipment of similar construction.

Webster's "International Dictionary" gives a similar definition of a reciprocating engine, but says that in a rotary, or rotatory, engine, "a piston, vane or the like is constrained to move in a circular path, thus obviating the necessity for a connecting-rod and a crank." It also gives the following description of a rotative engine, "an engine in which the reciprocating motion of the piston is transformed into a continuous rotary motion."

Another dictionary, however, seems to give the most emphatic definition of a rotatory, or rotary, engine as an engine in which the piston rotates in the cylinder or the cylinder upon the piston "without the intervention of reciprocating parts." It also refers to steam acting directly on "surfaces rigidly connected with the shaft to be set in motion."

Now the Gnome engine and its contemporaries are certainly not rotary engines in the same sense that a steam turbine is a rotary engine. A steam turbine consists broadly of two parts, a stator and a rotor the first is stationary and the latter in rotary motion. A so called rotary aëroplane engine of the Gnome type has also a stator and a rotor. The crankshaft is the stator and the rest of the engine is the rotor. So far, so good, but there are "wheels within wheels" in this case. The Gnome engine and its like are also reciprocating engines. For all their seeming "rotariness," to coin a word—they hide away pistons which reciprocate in their cylinders. Without the reciprocation of these pistons the mechanisms termed "rotary engines" would no longer be prime movers; they would be locked in such a case.

A perusal of the foregoing definitions makes it plain that no engine with reciprocating parts may be justifiably called a rotary engine. Gnome and similar engines *do* contain reciprocating parts; hence they cannot be rotary engines. They are reciprocating engines certainly, but the term "reciprocating engine" has been standardized to mean one particular type of reciprocating engine, and some other name should therefore be found for the Gnome type of engine which will convey the impression that, while they are reciprocating engines, they are by no means of the usual type of this class. The most suitable name appears to be "rotative engine," in which "the reciprocating motion of the piston is transformed into a continuous rotary motion."

The term "failure" has come to be loosely used as synonymous with disaster, etc. A piece of metal "fails" under such and such a stress in the testing machine. One speaks of a "flywheel failure" although the exploded wheel may have been racing at a speed far in excess than that for which it was designed. It was in this loose sense that we referred to the "failure of a condenser" in our issue of December 19. As was made plain in the article, the condenser was subjected to an internal pressure which it could not be expected to withstand and that it "failed" or exploded under such abnormal conditions is no reproach upon the apparatus or its makers.

The Otis Water Purifying System

The accompanying engravings illustrate a system which has just been brought out by the Stewart Heater Company, Buffalo, N. Y., for removing scale-forming materials and other impurities from boiler-feed water. The process is simple. It consists of heating the water in one vessel and passing the heated water through a filtering bed contained in another vessel. The high temperature (300 degrees or over, according to the pressure carried in the boiler) attained in the heater is said to precipitate all of the scale-forming materials, some of which deposit on the heater surfaces and some remain in suspension in the water. The water is passed through the filter to remove such matter as remains in suspension in it.

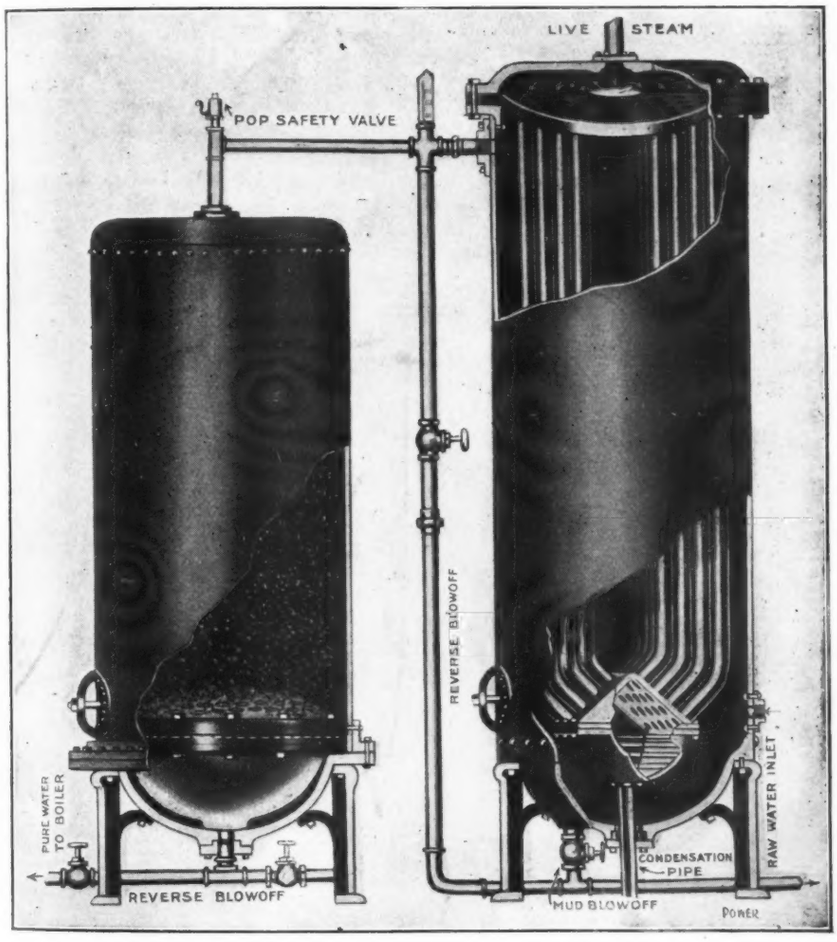


FIG. 1. THE OTIS WATER-PURIFYING SYSTEM

Referring to Fig. 1, the right-hand member is the heater, the construction of which is clearly shown. Live steam at boiler pressure is admitted at the top and fills the tubes. The water enters from the supply pipe or the ordinary feed-water heater at the "raw water inlet," near the bottom of the shell, and fills the shell up to the transfer pipe leading over to the filter. The heated water passes through this pipe and down through filtering beds of emery supported on perforated copper plates or trays, emerging from the filter tank at the bottom and passing to the boiler-feed main.

At intervals the deposits of foreign matter on the heater tubes and in the filtering beds are blown out by admitting cold water at the outlet of the filter tank and running it backward through the system. The cold water causes the heater tubes to contract and the scale which has deposited on them is thereby cracked off, according to the maker's explanation.

Fig. 2 shows the method of piping the system that is advocated by the maker. The feed-water supply is taken from the pipe *A* and normally flows into the heater through the valve *I*, the bypass valve *B*, back-flow valve *C*, relief valve *D* and blowoff valve *E* being closed. The cleansed water passes from the filter tank to the boiler-feed main through the pipe *F* and valve *G*. To cleanse the system, the steam supply is first shut off (valve *S*) and the water-inlet valve *I* is closed. Then the valve *D* is opened to let out whatever steam may be in the heater, and the valves *C* and *E* are opened. The former admits cold water to the bottom of the filter tank and the latter allows the water to discharge from the heater to the drain. Then the valve *D* is closed in order to force the backward flow of water from the filter tank to go through the heater. This back flow is continued until clear water comes out of the discharge pipe. While the cleansing process

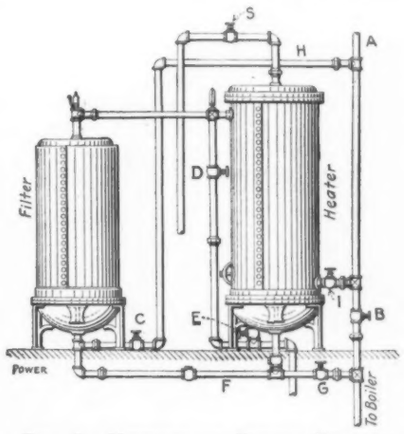


FIG. 2. METHOD OF PIPING SYSTEM

is going on, water may be fed to the boilers if necessary through the bypass valve *B*. When the purifying system is normally supplied with water which has passed through a heater, it is advisable to connect the back-flow pipe *H* with a cold-water supply instead of the feed-water supply, because cold water is preferred for cleansing the system.

Multiported Safety Exhaust Outlet Valve

An improved type of exhaust-outlet valve has been designed by the Harrison Safety Boiler Works, Seventeenth and Clearfield streets, Philadelphia, Penn.

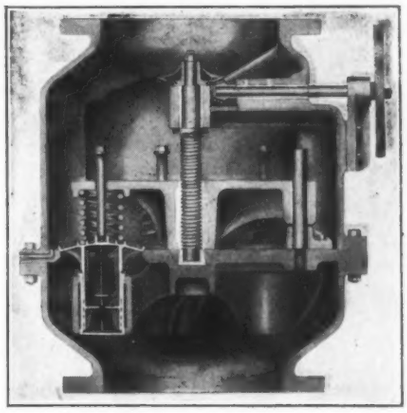
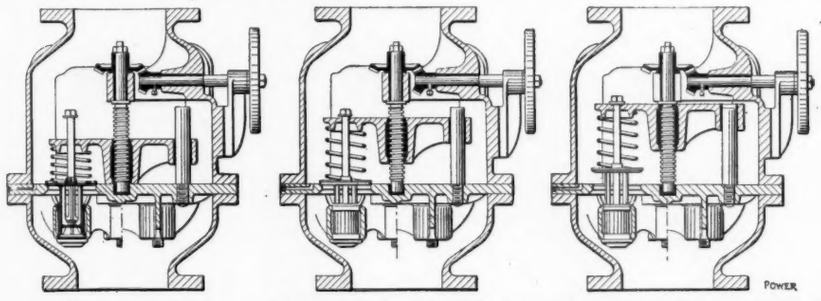


FIG. 1. COCHRANE MULTIPORTED EXHAUST OUTLET VALVE

An interior view of this valve is shown in Fig. 1. This valve has been designed for the purpose of discharging a large amount of steam at low pressure in a short time and also to keep the lift of the several valve disks as small as prac-

ticable and to operate without pounding on their seats.

The valve operates on the principle of the pop safety valve, in that the disks are held to their seats by springs, the tension of which can be varied within the range of the spring. When the pressure on the underside of the disks overcomes the resistance offered by the springs, the disks are forced open and the steam is allowed to escape to the atmosphere.



FULL PRESSURE VALVES IN CONTACT ONLY RAISED FOR FULL OPENING

FIG. 2. THREE PRINCIPAL POSITIONS OF PRESSURE PLATE IN COCHRANE VALVE

The valve may be described briefly as consisting of a valve deck upon which are placed a number of small valve disks, each individual disk being held closed by a spring. A water cushion or dashpot is also provided for each disk to arrest its motion and to prevent damage to the disk and its seat. Each disk may be lifted free of the seat by a stem when desired. The tension of the spring is determined by the position of a pressure plate, made adjustable by means of a vertical screw which may be turned either way by means of bevel gears connected with a horizontal shaft which extends to the exterior of the valve casing. This shaft is fitted with either a handwheel, chain wheel or a gear wheel. The valve deck is placed between the flanges of the bottom and the top castings, the latter having two or more handhole plates or doors for access to the valve deck.

From the type of valve disks used, their large number and the fact that they are made of bronze, as are also the linings of the dashpot, the probability of sticking is remote. Should one disk be deranged, all the other disks will continue in operation, and there is but a slight possibility that all of the disks of a valve will become inoperative at one time.

In the valve herewith shown, the aggregate area of the small disks is somewhat larger than the area of the inlet and outlet orifices, which provides generally an unrestricted passage for the steam when the disks are raised for exhausting free to the atmosphere.

The individual disks are small and light, and respond quickly when pressure is applied to them. The seating of the disks is retarded by a water cushion in the dashpots beneath them. The water in these dashpots is produced by the condensation of the steam.

Adjusting the tension of the spring is done by raising or lowering the pressure plate, but it is impossible for a certain pressure to be exceeded without substituting new springs; that is, when the pressure plate is down all the way, the springs are compressed to their maximum.

The three drawings in Fig. 2 illustrate the several positions of the pressure-plate and valve disks when the valve is set to the maximum back pressure. The first is set with the valve disks just touching the seat, as when only a few ounces of back pressure are required to force steam into a heater or other apparatus; a central position and finally with the valves raised to the maximum hight to allow free exhaust to the atmosphere.

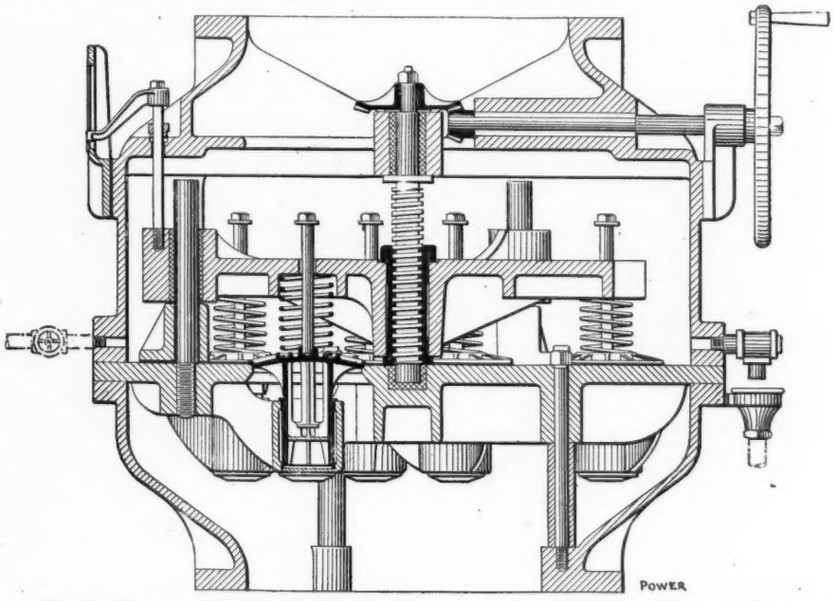


FIG. 3. OUTLET VALVE FOR VACUUM SERVICE WITH OVERFLOW TYPE OF WATER SEAL

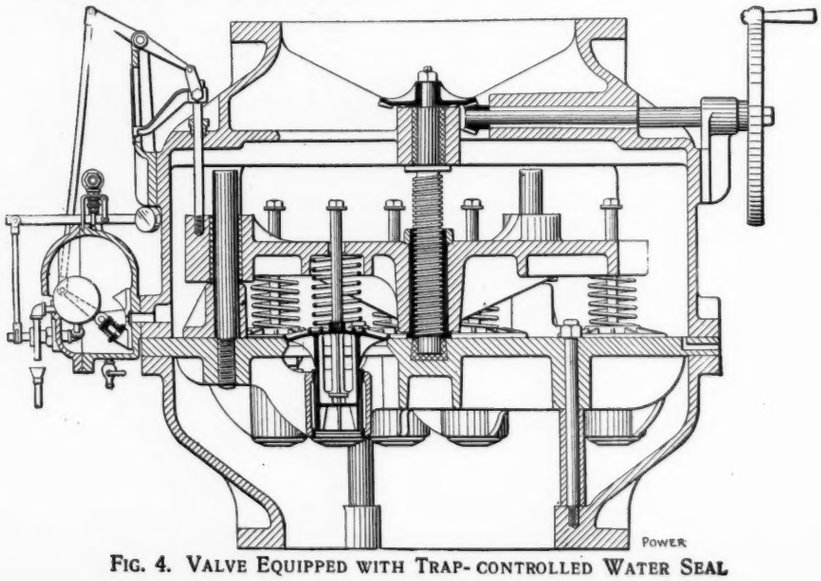


FIG. 4. VALVE EQUIPPED WITH TRAP-CONTROLLED WATER SEAL

In Figs. 3 and 4 are shown two types of back-pressure valves intended for vacuum service. They are fitted with light springs and are provided with a means of water sealing. The water seal may be of the simple overflow type, shown in Fig. 3, the water entering through the valve connected at the left and overflowing at the right, or it may be of the trap-controlled type, shown in Fig. 4, which is more economical of water, since when

the water reaches the required depth on the plate, the further admission of water is cut off by the float in the float chamber. In order to prevent waste of water when the valves are raised for exhausting free to the atmosphere, a system of levers is provided which closes a valve in the supply pipe. As may be seen in Figs. 3 and 4, an indicator is provided on the outside to show when the disks are fully raised or closed.

Sturdy Smokeless Furnace

The main feature of this furnace is the side-stoking magazine in which the grates are not only placed beneath the fuel but are on the outer side of the fuel as well. The fuel is held in place on the inner side of the furnaces by two sets of upright triangular water-tube grates which face each other in the combustion chamber.

The central compartment is covered with firebrick arches, as shown at *A*. The sides and back wall of the fuel chambers are lined with firebrick, and the floor of the combustion chamber is also so lined. The water grates are located 20 degrees apart, each set consisting of 20 upright hollow triangular-shaped bars with their narrow sides pointing inward and backward, as shown at *B*.

The fuel burns against and through the face of the upright water grates, the flame from each furnace chamber passing through the grates and impinging upon each other as they meet in the central chamber. The flames then pass beneath the central arch and along the bottom of the boiler sheet, returning to the front of the boiler through the tubes.

Air is forced into the compartment under the central combustion chamber and passes through openings to the ashpit under the grates.

The discharge pipes from the water grates connecting the top drum of the water grates with the sheet of the boiler; the intake pipe connects with the bottom drum. This arrangement produces a rapid circulation through the water grates.

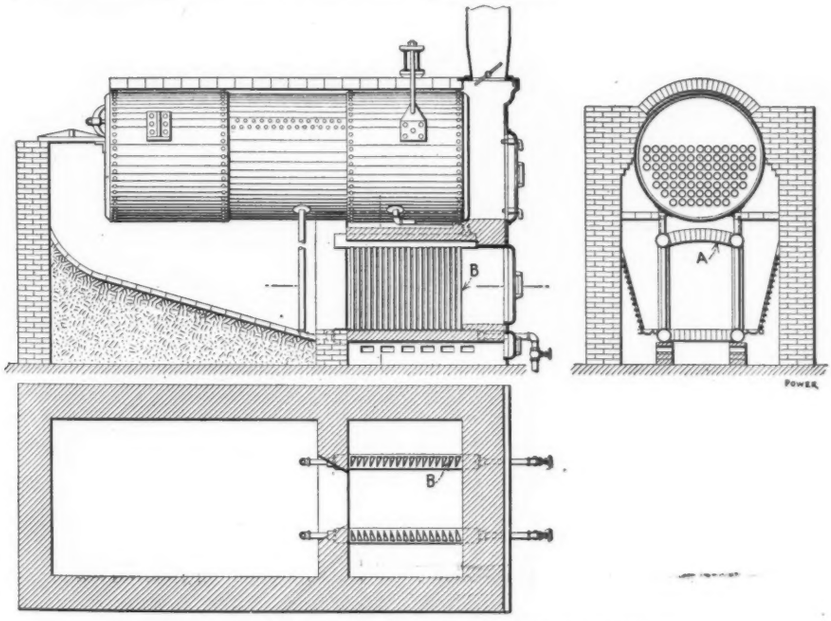
This furnace has been designed for burning any grade of coal, wood or shavings without smoke.

It is manufactured by the Sturdy Brothers, Buffalo, N. Y.

An Automatic Water Gage

When the ordinary type of gage-glass breaks, one is often forced to step lively in the effort to avoid the cloud of steam that is liberated, and the task of shutting off the connections to the glass is far from a pleasant one.

The accompanying figure illustrates the "Safeguard" automatic water gage, manufactured by the Penbertby Injector Co., of Detroit, Mich. This gage is designed so as to close automatically when the glass breaks.



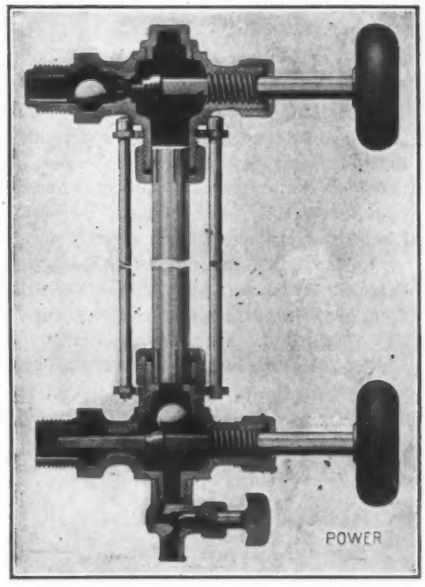
SECTIONAL VIEWS OF STURDY SMOKELESS FURNACE

Included in the lower or water arm of the gage are a stem and ball, the ball being supported upon the stem. That portion of the stem upon which the ball rides is square in shape, so as to give the ball an up-and-down movement when the handwheel of the stem is moved to screw the stem in or out. The ball, being disturbed by this movement, automatically cleanses itself from deposits, keeping its surface bright and clean so as to seat perfectly at the critical time of the breakage of the glass. Another effect of this movement is to prevent the formation of lime within the space of the ball chamber, the ball acting as a pulverizer of the deposits and not allowing such solid formation that it cannot be blown out.

When the gage stem is screwed in or out, a tongue shaped extension integral with the stem, beginning at the stem seat, rotates eccentrically through the shank of the gage to a point slightly within the boiler or column. This serves to prevent the formation of lime deposits.

The blowoff cock used in the fittings of this gage is so constructed as to be an important aid in the assembly and action of the gage, and because of its slow opening and closing movement, adds to its safety features. This has a screw-threaded stem of fine pitch which makes it impossible to open or close the cock suddenly, for when quick-opening cocks are used the glass bursts under the sudden release or formation of pressure and by the rapid change in the temperature of the glass.

The shank port in the upper arm of the gage is purposely made of extra-large area, that it may contain a ball and permit the formation of the ball seat. This seat is shaped square or hexagonal so as to prevent the tight seating of the ball. When the gage is in operation its action is promoted by the breaking of the gage-glass. This occurrence permits the pressure on the boiler side of the balls to attempt its release through the ball-seat ports, but the escape is promptly stopped by the balls finding their seats. When a new glass is tightened in, the boiler pressure is built up in the glass equally with that in the boiler. The equalization is accomplished by the steam flowing gently between the ball and its irregular seat in the upper arm. When the pressure in the glass becomes equal with the pressure in the boiler, the balls drop of their own weight and leave a clear circuit throughout the arms and the glass of the gage to the boiler or column space.



THE PENBERTHY "SAFE GUARD" WATER GAGE

Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Plugging a Well

Some time ago we had occasion to move two 16x9x14-inch crank-and-fly-wheel pumps from the ground level, where they had been operating, taking their suction from two 10-inch driven wells, to the bottom of a 25-foot concrete pit, and there connect them up

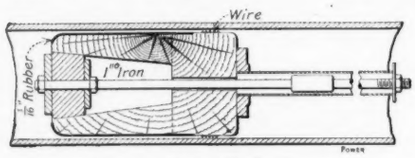


FIG. 1. THE WELL PLUG

again to the same wells and the same discharge pipe.

It was necessary, of course, to cut into each well at the proper point near the bottom of the pit and there insert a 10-inch flanged tee for the suction connection. It was found on investigation that the wells would have to be cut and threaded and flanges screwed on at a point about 10 feet below the water line in the well when not pumping.

Of course, some method of stopping the flow of water while this was being done was imperative, and it was up to us to devise one.

After rejecting such schemes as a bean bag, a piston with rubber rings, etc.,

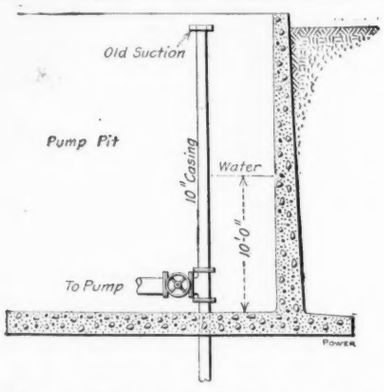


FIG. 2. LOCATION OF NEW PUMP SUCTION

the device shown in Fig. 1 was made. A piece of pine 18 inches long was turned to 9¾ inches diameter, and a cone-shaped hole turned in one end; this hole was made deep enough to allow a cone-shaped plug to expand the outer plug to somewhat more than the diameter of the well.

The annular part of the outer plug was cut with eight radial saw cuts to allow for expansion, and a dozen turns of heavy wire were made around the other end and soldered, which effectually prevented splitting.

A piece of 1/16-inch sheet-rubber packing was tacked around the outside, extending well above the saw cuts.

A plug was made to fit into the tapered hole, with an iron washer on each side held by nuts on the 1-inch iron rod in the center.

This rod was long enough to reach above the top of the well, and had a long thread on its upper end.

A piece of 2-inch pipe was fastened by a flange to the large plug, the 1-inch rod running inside this and extending a few inches beyond.

The method of using the outfit was to lower the plug in the well until the plug was below the cutting point; then the nut on the rod was screwed up, which expanded the eight sections of the plug and pushed the rubber firmly against the well casing. The well was then cut and threaded; a flange was put on, and a tee and valve bolted in place. Then the old piece of casing was bolted on top of the tee and the plug was removed. The casing was then capped; it now acts as an air chamber for the suction pipe.

The device worked all right, only a little water leaking into the pit. It might have been improved by 1/8 inch more clearance in the diameter.

B. S. NELSON.

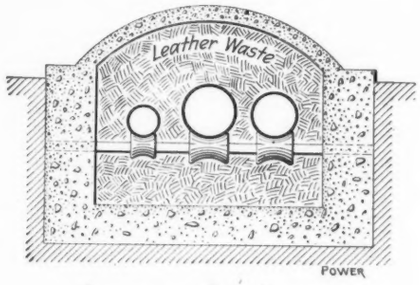
Bayonne, N. J.

Protection of Underground Pipes

I had occasion recently to cover some underground steam pipes and a description of the means taken to protect the pipes might be of interest to POWER readers.

The pipes were originally laid in plank boxes which had become badly decayed. I had the pipes dug up and a clear space left beside and under them. Then, I had about 2 in. of cement put down in the bottom of the ditch about 3 in. clear of the pipes, keeping them blocked up in the meantime. Next, I put 10-in. planks along the sides of the pipes, leaving about 1 in. clear between the planks and pipes and filled the sides back of the planks with concrete after putting iron rods with rollers at the ends of each section of plank so that the ends of the rods would be bedded in the concrete. After the planks were removed and the pipes were let down on the rollers. I had leather waste about the size of coarse sawdust packed around the pipes, leaving the top rounding full, after which I put cement mortar about 1 in. thick over the top. The idea was that the top could be easily broken up whenever it was necessary to get at the pipes.

This job proved effective, there being



SECTION OF PIPE TRENCH

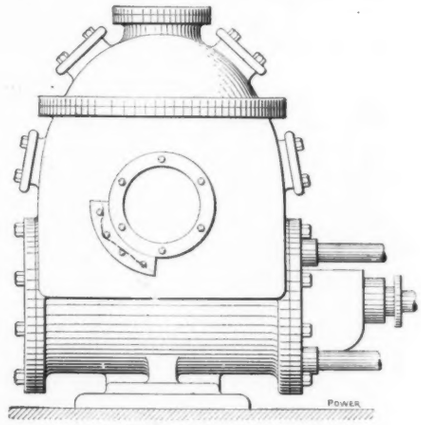
very little condensation. A section of the conduit would look something like that shown in the accompanying figure.

F. L. PERKINS.

Maynard, Mass.

Pump Cylinder Repair

I found when taking charge of a steam plant a few years ago, among other pieces of apparatus, a 10x16x18-in. vacuum pump and jet condenser, with a



SHOWING CRACK AND PATCH

crack in the water cylinder, as shown in the accompanying figure.

I learned from one of the oilers that the cylinder had been cracked about two years before; that one of the engineers had patched it, after a great deal of effort, with a large quantity of sheet packing. He succeeded in partly stopping the leak. At the time of which I speak, however, it leaked continually and seriously interfered with obtaining a good vacuum.

I had conceit enough to think I could put a patch on that place that would hold, but after repeated efforts with all the sheet packings and iron and steel cements known to me, I lost some of my conceit.

All were failures, and I was considering the purchase of a new cylinder, when I thought of the following repair: A piece of ½x2½-in. iron, 12 in. long, was bent edgeways for the patch and beveled on the inside edge to conform to the fillet on the neck of the boss. Then I drilled ½-in. holes 2½ in. apart, laid the piece on the cylinder, covering the crack as well as possible. The holes were marked, drilled and tapped for ½-in. studs, 2 in. long, regardless of where they came. Then I screwed in the studs and placed the patch in position, leaving a space of from ¼ to ½ in. I then placed wood forms plastered with clay all around the piece, leaving a hole at the highest point, after which molten lead was poured, the form removed and the nuts tightened, at the same time the patch was lightly tapped with a hammer. The pump was then started, and has been running ever since, with never a sign of a leak.

In justice to the iron and steel cements, I will say that I think that with the same method of repair the cements would have been as effective, although not as quick to set.

CHARLES W. HOPES.

Glens Falls, N. Y.

Civil Service Examination

Having read with interest many discussions in POWER of the relative virtues and vices of existing and contemplated State license laws, I believe that a brief description of the civil-service laws of Illinois might be of value to those not familiar with this class of service.

The Illinois civil-service laws govern all employees of the various State institutions, but I refer particularly to those which have to do with the examination and the listing of firemen and engineers.

There are three grades of examinations: firemen, stationary engineers and chief engineers. Applicants for such positions are required to pass an examination before entering the service, but a man who successfully passes the engineers' examination can hold a position as fireman and similarly one who has passed as chief engineer can hold practically any position in the engineering department of the service.

Applicants for examination as fireman are required to be American citizens, residents of the State, 21 years of age, and physically and morally capable of taking charge of a boiler room. Furthermore, they are required to give at least three good references and to show where and for what time they have been employed during the previous five years.

The examination, which is quite strict and practical, may be written or oral, or both, and it usually lasts from three to five hours. A minimum percentage of 70 is required for passing and as experience counts 50 per cent. and technical knowledge, etc., counts 50 per cent., it is plain that a man with book knowledge and no experience cannot pass, and *vice versa*. Any serious-minded man with a year's previous experience and good habits ought to make a fair showing, however.

The engineers' examination is similar to the firemen's, but it is much more difficult.

When I took the test, which was nearly all written, I scribbled from 9 a.m. to 4 p.m., answering questions on boilers and pumps, heating and ventilating, refrigeration, electricity, steam engines, indicator practice, practical, everyday problems and mathematical computations. I got an average of 92 per cent. and my name was second out of 43 on the eligible list. This examination, although somewhat shorter, was about on a par with those which I took for licenses in two different cities.

An engineer having passed successfully is eligible for appointment in any of the State charitable institutions. The Kankakee State hospital, where I am employed as stationary engineer, is the second largest in the United States; it has a 2000 boiler horsepower, 500-kilowatt electric plant, waterworks, a refrigerating and ice plant, etc., and engineers leaving it with a year's experience and a good recommendation from the chief engineer or the superintendent have no trouble getting good jobs anywhere.

The chief engineers' examination is quite severe, owing to the varied requirements. Applicants must be 25 years of age, preferably with a previous experience as chief and at least five years as engineer and a 10-year total mechanical experience.

The examination, usually written, takes a whole day and the questions pertain to the larger problems of design, installation, operation and maintenance of modern power-plant apparatus as well as finer details. This was the hardest examination I ever took, but I passed with an average of 86 per cent. and am now eligible for appointment as chief in any institution in the State which is controlled by civil-service laws.

All chances for fraud in these tests are eliminated as far as possible; when the applicant enters the room all books, reference papers, etc., are taken from him and he then draws a number which he seals with his name in an envelop that is sent to the secretary of the civil-service commission at the State capitol. His papers are then signed by that number, so that the board of engineers who grade them have no idea of the writer's identity.

The examinations are without cost. The applicant must take an oath before a notary and must get a health certificate from a physician; both are free at the institutions where tests are held, but would cost about 75 cents outside.

Upon discharge from the service the employee's name is taken from the eligible list.

If we are to have State license laws, let them be similar to the civil-service laws and their success, in my opinion, is assured.

ERNEST B. LLOYD.

Kankakee, Ill.

A License Does Not Make an Engineer

A license does not make an engineer. For instance, a simple throttling engine was thrown out and a large Corliss engine installed in its place. The engineer had a license, but he could not manage the new engine, and his job fell into the hands of an old chief engineer and things got worse. He burned out a bearing and excused himself by saying that he had been used to running plants where they had someone to look out for the engine. I think this is true of many chief engineers—they have someone to hold them up, and when they depend on their own resources they fall down.

Another engineer, without a license, obtained the job and the engine is running nicely, and the plant is in first-class condition. This man without a license is there with the goods.

I am not against the license law at all. I think it does a lot of good—but there are plenty of men without them who can hold their own with the next one.

C. R. MCGAHEY.

Baltimore, Md.

Kerosene in Blowoff Pipe

In the plant where I am employed it is customary to put about two quarts of kerosene in each boiler before filling with water after washing. Recently while washing out one of the boilers the blowoff became clogged with scale, which was removed by taking off the blowoff-valve bonnet. This was replaced, the oil put in and the boiler filled as usual, when a small stream of oil was found running from the joint between the bonnet and the body of the valve and which continued to run until all of the oil had run out.

This raised two questions which I cannot answer: Why did not the oil rise to the top of the water in the boiler instead of staying in the blowoff pipe? If the oil had not leaked out at the flanges, would it have got hot enough to explode?

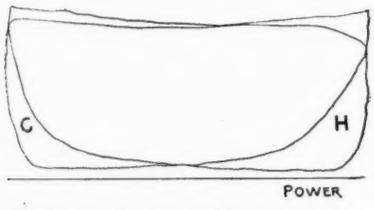
A. STAMBAUGH.

Weleetka, Okla.

Some Load!

The accompanying diagrams were taken from an 18x42-in. Corliss engine of well known make. The engine makes 82 revolutions per minute.

I have taken indicator diagrams from upward of 3700 cylinders in the last 14 years and this is the heaviest load that I have yet found.



DIAGRAMS SHOWING HEAVY LOAD ON ENGINE

I would like to hear from other readers as to the amount of loss due to the lack of expansion. In other words, what is the difference in steam consumption between this engine and one which cuts off so as to obtain the full benefit of expansion?

H. I. FRYANT.

Jackson, Miss.

Measuring Furnace Temperatures

The following method of finding the temperature of a furnace, although approximate, is accurate enough for all practical purposes.

By means of the accompanying formulas and tables the temperature can be read off at a glance without having recourse to elaborate calculations.

In the *Journal of the Worcester Polytechnic Institute* (November, 1906), C. F. Howe and C. B. Harrington have an article on tests which they performed on firebrick to determine its specific heat. From the data given in that article, after reducing to practical units, I have obtained the following formula for the specific heat of firebrick:

$$S = 0.000034\ T + 0.213 \qquad (1)$$

where T is the temperature to which the firebrick is subjected and S is its specific heat at that temperature.

In Table 1 is given the specific heat of firebrick at different temperatures deduced from formula (1).

TABLE 1

Temperature T, degrees F.	Specific Heat S,
200	0.220
400	0.226
600	0.233
800	0.240
1000	0.247
1200	0.254
1400	0.261
1600	0.267
1800	0.274
2000	0.281
2200	0.288
2500	0.298
3000	0.315

Since a firebrick can be easily obtained around any furnace, the temperature of the furnace can be found from the following formula:

$$T_3 = \frac{W\,(T_2 - T_1) + T_2 GS}{GS} \qquad (2)$$

T_3 = Temperature of the furnace;
W = Weight of water in which firebrick is quenched;
T_2 = Final temperature of water after brick has been quenched;
T_1 = Original temperature of water before immersion of firebrick;
G = Weight of firebrick used;
S = Specific heat of firebrick.

If from Table 1 is taken the average specific heat of firebrick from 200 to 2000 degrees (the range of temperature through which the firebrick would probably be heated) it is found that this amounts to about 0.25.

Take a piece of firebrick 4½x2½x4 inches in size (the standard size of a firebrick is 2½x4½x9 inches), which will weigh about 3 pounds. Now take 17 pounds of water, about 2 gallons, and formula (2) may be reduced to the following form:

$$T_3 = 23.7\ T_2 - 22.6\ T_1 \qquad (3)$$

Making $T_1 = 70$, there is had

$$T_3 = 23.7\ T_2 - 1586 \qquad (4)$$

In Table 2 is given values of T_3, corresponding to the temperatures T_2 deduced from formula (4).

So that all that is necessary to obtain the temperature of a furnace is to take a piece of firebrick 4x4½x2½, which will weigh about 3 pounds. Place this in the furnace and let it heat up to the temperature of the surrounding gases. Meanwhile, prepare 17 pounds of water at a temperature of 70 degrees. Remove the piece of firebrick from the furnace and quickly transfer it to the water. Keep on stirring the water until the thermometer no longer shows any increase. Then, by noting this highest temperature, which is designated as T_2, the temperature of the furnace, which is designated as T_3, may be found in Table 2.

TABLE 2

Final temperature of water T_2, degrees F.	Temperature of furnace T_3, degrees F.
80	310
90	547
100	784
110	1021
120	1258
130	1495
140	1732
150	1969
160	2206
170	2443
180	2680
190	2917
200	3154

SAMUEL B. KANOWITZ.

Baltimore, Md.

This Man Hates Us!

I own a threshing rig and steam plow. Would like to send you some views this winter. I am running the engine in the mill here and I also have charge of the city electric-light plant.

Reading POWER did it!

P. C. FORGARD.

Lake Preston, S. D.

Oil in Boilers

About two weeks ago the girth seams of one of the boilers which I am operating began to leak. After examining the boiler I found that there was oil in it.

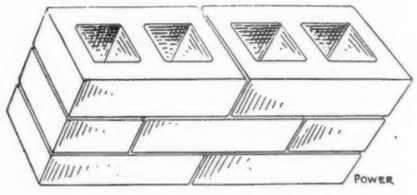
I took out the back manhole plate and, after filling the boiler above the flues, I put in 40 lb. of sal soda and ½ gal. of coal oil. I kept a slow fire under the boiler and let the mixture boil 18 hours. After opening up the boiler again and washing it out, I found it perfectly clean, there being no traces of oil in it whatever, and when the boiler maker had calked the seams it was in fine shape.

A. S. DILLON.

Kansas City, Mo.

Brick for Boiler Walls

The accompanying illustration shows a brick with a hollow space in the center, which I would suggest for use in building partition and outside boiler walls.



BRICK FOR BOILER WALLS

I would like to have the opinion of POWER readers on whether boiler settings of hollow brick have ever been built, and whether they have been satisfactory.

LEWIS L. SCHEIDERER.

Marysville, Ohio.

Glass Gages Break on Separators

There are 80 steam separators in this city and there is not one that can hold a glass more than two weeks. Why should there be any more trouble with glasses on separators than elsewhere? I wonder if engineers generally find this to be the case.

J. W. DICKSON.

Memphis, Tenn.

Water Softeners

I would like a little information from those who have had experience with water softeners or purifiers and filters for preventing the scale-forming matter from getting into the boiler and with what results; also, some data as to cost per thousand gallons purified. I have been told that water so treated will leave a scale so hard that a mechanical cleaner will not cut it.

I am not in favor of boiler compound to get rid of scale because this is trying to cure the effect instead of removing the cause.

J. C. HAWKINS.

Hyattsville, Md.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Large Saving in New York City's Coal Bill

In view of the publication, in a recent issue of POWER, of statements on the authority of the Bureau of Mines that "by purchasing coal under definite specifications bidders are put on a strictly competitive basis, the purchaser is insured against poor quality, rejectable coal may be accepted at reduced prices, and there is a check on the practicable results obtained," the experience of the department of water supply, gas and electricity of New York City during the past year is of interest.

This department has the largest fuel bill of any of the departments of the city government. Practically all of the water supply of the boroughs of Queens, Brooklyn and Richmond is obtained from driven wells, and the pumping of this water and the maintenance of the pressure throughout the other boroughs necessitate the operation by the department of fifty-two pumping stations. The enormous amount of coal used in these stations is seen from the fact that when Commissioner Henry S. Thompson assumed office on Jan. 1, 1910, the annual coal bill had, for many years, approximated $600,000. This was one of the first matters which Commissioner Thompson took up when he reorganized the department, and the result of the working of the new methods which he put into use was a reduction in coal cost in 1910 over 1909 of $122,514. This is a decrease of nearly 25 per cent. in one year and the commissioner expects the bills to show a further reduction for 1911. Together with this decrease in the coal bill of the department, 2.5 per cent. more water was pumped by the various stations in 1910 than in 1909.

While the cost per ton of the various kinds of coal used was not decreased to such a large degree, the quantity of each kind of coal was substantially rearranged. The price of broken coal, of which 64,001 tons were purchased in 1909, was reduced from $4.97 to $4.90 a ton, but only 7742 tons were purchased in 1910; this made a difference of $23,235 in the total bill of $317,876.

The greatest reduction in the price per ton was obtained in pea coal, which was bought at $4.04 per ton in 1909 and for $3.89 in 1910. At the same time, several more hundred tons were purchased in 1910 than in 1909, the total being 25,948 tons in 1909 and 29,202 tons in 1910.

No reduction in the price of buckwheat coal was obtained, it being bought at $3.04 per ton for both years, but many more tons were purchased in 1910 than in 1909, the figures being 80,064 as against 16,346 tons. This made an increase on this item of from $49,732 to $243,394.

The offset to this and the bringing about of the enormous decrease was obtained by the rearrangement of the purchasing of bituminous coal in the same manner as that of broken coal. A reduction per ton was obtained here also of from $3.80 to $3.73 and the amount purchased was reduced from 37,179 tons to 29,777 tons.

Commissioner Thompson called to his assistance in this work several coal experts, and the specifications which he adopted have since been standardized by the board of estimate and apportionment and are now used in the purchase of coal for all of the other city departments.

E. F. HARVEY.

New York City.

A Commercial Water Power Problem

I read with much interest the article by Prof. W. D. Ennis under this heading in the November 14 issue, and while his figures might be correct for the condition under discussion, I do not think that they should be taken for any other condition at the same rate per horsepower. Taking his figure of $25,000 as the value for a 60.3-horsepower water supply, there is a value of $41.45 per horsepower. In Kent's "Mechanical Engineers' Handbook" a similar calculation is given where the computed value of a 10,000-horsepower water power was worth $445,000, or $44.50 per horsepower. This is a close agreement.

I do not think it safe to assume a water-power right to be worth $40 to $45 per horsepower. In my opinion, the value depends entirely on local conditions. Where coal or other fuel is cheap it is worth less than where it is expensive. When exhaust steam is used the power is not as valuable as where it cannot be used and the units are too small to run economically with condensers. Where a large power plant is required the rate per horsepower should not be as high, since turbines can be run very cheaply compared with condensing or noncondensing engines. To my mind, the value of water power is no greater than a sum of money which, when placed at the legal rate of interest, would produce an income equivalent to the actual cost of getting the power elsewhere or producing it with the most economical machinery. In other words, if the power required is enough to justify a high-efficiency turbo-electric unit producing a horsepower for an hour on 2½ pounds of coal, the value should not be based on the cost of producing the same with engines using 3 to 5 pounds of coal just because they happen to be on the ground. Suppose at a later date a power station should be erected in the vicinity which would furnish power equivalent to the cost based on 3 pounds of coal. It will be seen how much money would be lost by buying the water power on a 5-pound rate. If the power were leased on the 5-pound rate, it would certainly have to be dropped under the foregoing condition.

A small user of power could afford to pay much more than a large user. In small plants the cost of a horsepower-year is very high. The labor costs are nearly as much as in a larger plant and in many cases the plant is too small to justify any kind of fuel-saving devices. In fact, most small plants do not have a first-class engineer in charge; usually it is any common laborer who will keep up steam and have the plant in good enough shape to run. They may only get 5 pounds of water evaporated per pound of coal and the engine may consume 50 pounds of steam per horsepower-hour and yet it would never be suspected. To such plants a water power based on 5 pounds of coal per horsepower-hour would be a great saving. To a high-grade plant it would be a big loss.

Another important factor to be remembered is the variability of water flow. In the summer months the flow is so low that many plants are forced to shut down or maintain an auxiliary steam plant. The winter flow is much more, and is often greater than the wheel capacity. In this case the power is worth more than the minimum but less than the full wheel capacity. In this case allowance must be made for the cost of maintaining the auxiliary plant or the necessary expense entailed in the annual summer shutdown because of lack of

water. It would be out of place to try to outline a plan for calculating the value under these conditions as it would vary greatly and be governed entirely by local conditions.

As to the value of water for condensing, Professor Ennis attempts to make the water more valuable as a power producer for this purpose than when it is used in a wheel. I disagree with him on this point. I claim that the water is worth no more for condensing than the cost of pumping from the tailrace to the condenser. The efficiency of a waterwheel will seldom go above 75 per cent. and the efficiency of the best of pumps is about 70 to 80 per cent. Since the power owners cannot claim the water after it has gone below the dam, it would be impossible to prevent the pumping back. Of course, the cheapest way would be to buy an extra amount of water if the power house is up above the dam, but I contend that this water should not be charged higher for on account of the saving effected by improved machinery, but should be sold at the regular power rate. As a rule, power houses are situated as low below the dam as is consistent with local conditions, and in many cases the condensing water can be pumped as cheaply as the water power is worth.

The estimation of the value of undeveloped water power is a matter requiring a thoroughly competent engineer, or better, a board of engineers. It is easily seen that a comparatively small water power is worth a large sum of money, and anyone buying or selling such a source of power would save considerable money by getting advice from several competent engineers experienced in such work.

JAMES E. STEELY.

Covington, Va.

Prof. W. D. Ennis, in his article on the above in POWER for Nov. 14, gives a method for computing the discharge of water through a large opening under a low head that is unnecessary and misleading as it pretends to give a degree of accuracy that is not warranted in the case. In the first place, it is not apparent why he should have computed the results he gives at all, as the diverging mouthpiece on the opening makes the calculations of no value. If, however, it is desired to estimate the flow through such an orifice as his calculations are made for, it is unnecessary to do so in such a round-about manner. Furthermore, an exact method for such a case is not warranted.

In this instance there was an opening 6 ft. wide and 6 in. high, with a head of water on its upper edge of 2.5 ft. Since the head varied from 2.5 to 3 ft., he computed the velocities at different depths, and after plotting a curve obtained the mean velocity which, when multiplied by the area, would give the flow. This is not necessary, as any good textbook on hydraulics would give an exact formula as follows:

$$q = c\frac{2}{3}\sqrt{2g}\, b\,(h_2^{\frac{3}{2}} - h_1^{\frac{3}{2}})$$

where

q = Cubic feet per second;
c = Coefficient of discharge;
b = Width in feet;
h_1 = Depth of upper edge in feet;
h_2 = Depth of lower edge in feet.

This exact formula is to be used only when there is a very low head in proportion to the height of the opening; for if,

d = Height of opening = $h_2 - h_1$;
h = Mean depth in feet.

It can be written

$$h_2 = h + \frac{d}{2} \qquad h_1 = h - \frac{d}{2}$$

and putting these values in the above formula there is a rapidly converging series as follows:

$$q = cbd\sqrt{2gh}\left[1 - \frac{1}{96}\left(\frac{d}{h}\right)^2 - \frac{1}{2048}\left(\frac{d}{h}\right)^4 - \cdots\cdots\right]$$

It is apparent that if the value of h is two or three times d, all terms involving $d \div h$ can be neglected; then is had

$$q = cbd\sqrt{2gh}, \text{ or } v = \sqrt{2gh}$$

This latter formula is the one usually used for, except for very large values, of d divided by h, it is as accurate as the reliability of the coefficient c warrants.

In the present case the exact formula gives

$$q = c\frac{2}{3}\sqrt{2g}\ 6\ (3^{\frac{3}{2}} - 2.5^{\frac{3}{2}}) =$$

$$c \times 39.9 \textit{ cu.ft. per sec.}$$

The simpler formula gives

$$q = c\ 3\sqrt{2g \times 2.75} =$$

$$c \times 39.916 \textit{ cu.ft. per sec.}$$

The slight difference between the two is thus shown. In the case of a standard orifice with sharp beveled steel edges the coefficient c would not be reliable in the third figure perhaps, and in such a case as this one could not select a coefficient which could be depended upon in the second figure. The author chose a value of 0.60, and, as that is not exact, all that can be said is that the flow will be about 24 cu.ft. per second. To attempt such refinements where the circumstances do not warrant it and to give an air of great accuracy where the reality is absent is as bad as the "German method" of guessing at the load on a bridge and calculating the stresses to half a pound.

The article further states that the true ideal velocity is greater than $\sqrt{2gh}$, where h = mean depth. The reverse is shown to be true by the values of discharge computed above and it is also shown by an inspection of the equation in the expanded form.

R. L. DAUGHERTY.

Ithaca, N. Y.

Length of Belt

Referring to the answer given to the question of R. F. H. as to the length of a belt, as printed in the Nov. 28 issue, not many of us are sufficiently familiar with the tables of geometrical functions to work the formula readily. I offer one for readers of POWER that I have used many years. It is more simple and therefore more easily worked out. It is not absolutely correct, but the error is inconsiderable.

The formula is based on the assumption that the line of the belt, in relation to a line drawn through the centers of the two pulleys, may be taken as the hypotenuse of a right-angled triangle whose height is the difference between the radii of the two pulleys and its base the distance between the two centers. Twice the length of the hypotenuse added to half the circumference of the two pulleys will give the length of the belt very closely.

Let

R = Radius of the large pulley;
r = Radius of the small pulley;
D = Distance between centers;
L = Length of the belt.

Then

$$\sqrt{(R-r)^2 + 2D^2} + (R+r) \times 3.1416 = L$$

Taking the conditions of R. F. H.'s problem, L would equal 92.858 feet.

Working out the problem by the previous formula as a check on mine, the result is 92.9019 ft., a difference of 0.0439 ft. or 0.5268 in. in 92 + feet.

WILLIAM HIRST.

Trenton, N. J.

Manufacture of Switchboard Slate

In the November 21 issue, J. J. O'Brien describes a device for sawing slate. The design of this tool and the method of using it seem to be based on the idea that slate is machined similar to other stone. Such is not the case, as I am aware from having been employed for over three years in a slate factory where all manner of slate products were manufactured, including switchboards of all sizes.

All dimensional cutting is done with low-speed circular saws with swaged teeth, and curves and circular cuts are made with an ordinary woodworking bandsaw run at low speed. The speed of slate saws, as I have seen them used, is about 100 feet per minute, and the feed rate about 3 to 6 inches per minute ordinarily, although practice may vary in different localities and with different grades of slate. A circular saw for or-

dinary work is from 18 to 24 inches in diameter and about $\frac{1}{16}$ inch thick. For light work the saw is smaller and thinner. Any saw that will cut wood will cut slate, but it must not be hurried.

All other operations in machining slate are practically the same as for metal, and no water is used on any saw or tool. If the slate is of good quality and free from flint, mineral veins and spots, a tool will do a lot of work before resharpening is necessary. The dark, natural finish that we are familiar with on slate is produced by first rubbing the piece perfectly smooth with fine emery cloth and then applying a mixture of boiled linseed oil and paint drier. The excess oil is then absorbed with sawdust and the slate is polished by being rubbed with clean waste.

H. L. STRONG.

Portland, Me.

Value of CO_2 Recorder

Much has been said recently in POWER of the importance of CO_2 recorders. Most operating engineers are, in my opinion, somewhat skeptical of such apparatus; furthermore, I believe that many of them take a similar attitude toward all recording instruments.

It appears to me that several of the recent contributors have been discussing the subject from a theoretical aspect rather than from an educational or practical one. I suggest that it be so discussed that whatever is said may be of material value.

Most engineers who do not attach much importance to flue-gas analysis and CO_2 recorders, take such an attitude simply because they are not sufficiently interested in the subject, and because they do not consider boiler-room performance of paramount importance in the everyday operation of the power plant.

Frequently men are opposed to the CO_2 recorder because they have the wrong impression of what it really is designed to accomplish.

I made the following analyses about 18 months ago in a plant burning Island Creek coal under return-tubular boilers, with straight grates fired by hand:

The heat value is 14,709 B.t.u. per pound, as reported by the West Virginia Geological Survey.

In a contributed article on this subject about a year ago I drew the following conclusions:

1. The draft must be sufficient to cause the coal to burn with a bright flame, if good combustion is sought; however, an excessive draft is objectionable in a greater degree than a somewhat insufficient draft, as in the majority of plants a too low evaporation per pound of coal is caused by excess air rather than by carbon monoxide.

2. Smoke cannot be entirely eliminated with a straight furnace (set in accordance with standard specifications) no matter how efficient the fireman may be.

3. The absence of smoke is not an indication of ideal conditions, as they are most frequently secured by the admission of an excess of air, and at the expense of the coal pile.

4. A good flue-gas analysis is preferable to a smokeless stack. The condition to be sought is to get the CO_2 as high as conditions will permit without getting more than a trace of CO.

5. Mechanical stokers cannot make a saving in fuel in comparison with hand firing, unless close attention be given to the prevention of holes or bare spots in the fire; also, most mechanical stokers secure smokeless combustion with volatile coals by the admission of an extreme excess of air.

When I sent this contribution for publication I expected to stir up a valuable discussion upon the subject of flue-gas analysis, but to my disappointment there never appeared a single dissenting line.

Referring to conclusion No. 4, generally speaking, it is advisable to have such conditions as to get the highest possible percentage of CO_2 with only a trace of CO. However, as there are constituents of the products of combustion which are far more valuable from the standpoint of heat value, it is of greater importance to find out by actual working conditions at which particular percentage of CO_2 the highest evaporation per pound of coal can be secured.

Let several evaporative tests be run, the first being run while using the evenly spread fire, aiming to get the highest possible percentage of CO_2.

Let the second be run using the coking method of firing, the main object being to prevent smoke, while using approved methods of cleaning the fires and aiming at all times to prevent an unnecessary excess while cleaning fires, all other conditions being the same.

Let the third test be run using about 0.25 in. of draft over the fire, using the ribbon method of firing and maintaining the fire bed only thick enough to cover the grates, with just a little excess of air over the fire, all other conditions being the same as in the other two tests.

To me there is no question whatsoever but that the last test would make by far the best showing in evaporation, if they were all three equally fair and correct; furthermore, there is no doubt but that the CO_2 would be somewhat lower than in either of the other two tests. Of course, it is understood that the present discussion refers to a highly volatile coal.

Eighteen months ago I thought that the CO_2 should be just as high as possible, say 14 to 15 per cent., but I am convinced that while such a percentage of CO_2 would be advisable in burning a coal low in volatile matter, it would be extremely detrimental to economy in burning a coal high in volatile matter.

In conclusion, I would offer the following:

1. A high percentage of CO_2 is not necessarily an indication of the highest possible economy when firing volatile coals.

2. The percentage of CO_2 should not be as high for highly volatile coals as for those of a semibituminous nature, such as New River and Pocahontas.

3. That under usual conditions a semibituminous coal (Pocahontas) will evaporate much more water per pound of coal than a highly volatile or bituminous coal, both having an equal heat value.

4. That carbon monoxide is not of any great importance, insofar as economy is concerned in everyday practice.

5. The combustion of the hydrocarbons is of greater importance than the prevention of CO if highest economy is desired.

6. Slack or small-size coals give a much higher evaporation per pound of coal in everyday practice than run-of-mine or lump coals.

7. A combination of the alternate and spot methods of firing is most economical and practicable with hand firing.

8. The maximum economy in fuel is more easily maintained with mechanical stokers than with hand firing.

9. All recording instruments are extremely valuable and necessary if economy is to be secured in everyday operation.

WALDO WEAVER.

Tippecanoe City, Ohio.

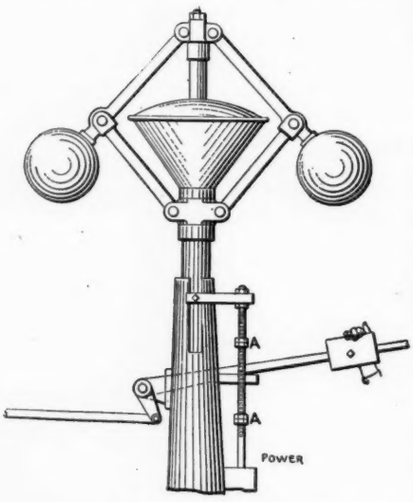
To Stop a Runaway Corliss Engine

After reading the account of the Farmington, Utah, flywheel explosion in the Nov. 14 issue, one might feel inclined to criticize the engineer in charge of the plant. But if one will stop to consider, he will see how easy it is for a man up a tree to criticize a man in a field running a foot race with a bull, and if he should get in first show him where he failed to show class. Also, there is a vast difference between a man sitting at a desk reading and one standing in front of an 18-ft. flywheel running at 200 r.p.m. when its normal speed should be 50.

So, instead, I will say that it is not necessary to close the throttle of a Corliss engine to bring it to a standstill. With a few exceptions Corliss engines are equipped with the ordinary fly-ball type of governor, and if the pulleys or belt do not slip, the weights are thrown to their highest position when the engine starts to race, thereby cutting off the steam. Also, if the governor belt breaks, the governor will drop to its low-

est position; if the nuts *A* in the accompanying figure are in their proper position, the safety cams will come under the roller, thereby preventing the valves from hooking up.

So, if any beginner is caught like the



TO STOP ENGINE PULL WEIGHT ARM DOWN TO LOWEST POSITION

man at Farmington, he need not risk his life in front of the runaway flywheel but may just reach over from the back side of the engine and pull down the governor arm and hold it there until the speed gets back to normal.

A. W. GRISWOLD.

Adams, Mass.

License Laws

Regarding the engineers' license laws, I do not think they are what they should be, because too much of the examination is given over to finding out how much the applicant knows about machinery in general and not enough to his knowledge as to safety.

How many examiners ever ask an applicant to calculate the safe speed of a given flywheel? And yet nearly every week POWER publishes an account of a flywheel explosion or engine wreck.

How many engineers are ever examined as to their knowledge of different kinds of governors, their safe operation and faults? Yet the operation of the governor or its failure is often the cause of a wrecked engine.

If the valves on the engine are not properly set, it does not make it unsafe to operate, yet in one examination for a second-class license I was required to set the valves on five separate engines to run in both directions, but not one question was asked about flywheels or governors.

The examinations on boilers and piping should be more strict.

Some of the writers in these columns say that the State and municipal laws should be superseded by a Federal law. This, if properly done, would be the ideal way of deciding the matter, as a license good for a certain class plant in one location would be good anywhere in the United States for the same class of plant. While a Federal law in this respect would be desirable, it would be impossible to get it as it would be an infringment on States' rights and would have to be voted on by the people of the several States and also acted on by Congress.

The license laws at the present time base the classification of licenses on the horsepower of the plant regardless of the pressure carried. I believe this is partly wrong, because a plant of 100 horsepower is just as dangerous and as liable to explosion as one of 500 horsepower, although a higher grade of license is required for the latter plant. The pressure carried as well as the size of the boilers in the plant, together with their number and age, should determine the classification. As the boilers become older the higher-class engineer should be required because the boilers are not as safe and require closer and more expert attention; this is the reverse of what is the usual practice.

If the engineer desires to have a license or certificate of merit or ability to show his competency to handle a given class of plants, let him do so in some such manner as outlined by the Institute of Operating Engineers, which is now being started, and not by compulsory laws as at present.

Several engineers have suggested the civil-service examination for licenses, but if the lists of civil-service questions were asked in an examination for a license to operate a plant, the engineers would set up a great cry of protest.

J. C. HAWKINS.

Hyattsville, Md.

Drain Grating for Cement Floors

A good drain grating for cement floors can be made out of old furnace grates that have outlived their usefulness. The wornout furnace grates should be broken into pieces of the desired length, and then embedded in the concrete at the time the floor is being put down.

H. M. NICHOLS.

Kenyon, R. I.

Substitute Trap Bucket

In the issue of November 14, P. J. McEnaney's letter describing the temporary substitution of a can for the bucket in a steam trap made no mention of weighting the can to insure satisfac tory operation.

If the can was too light and the pressure high, the valve would be held tightly against its seat, and the combined weight of the bucket and the water would be insufficient to pull it away and allow the trap to discharge. In several instances I have caused traps whose maximum pressure range is 40 pounds to operate under a higher pressure without reducing the size of the discharge orifice, which is necessary with an increase of pressure, simply by adding weight to the bucket. Of course, there is a limit to the amount of weight added, and I have found it impractical to add much more than would give 15 or 20 pounds over the maximum pressure for which the trap is intended.

W. SIMPSON.

New York City.

Crankpin Oiler

Answering Fred L. Wagner's letter in POWER for Nov. 28, I fail to see why my arrangement described in the Oct. 3 issue would not deliver almost as much oil to the crankpin at low speed as it would at high speed, as it does not depend on centrifugal force to carry the oil to the crankpin; it is simply assisted by this force, for every time the crank is down, the oil flows to the pin by gravity.

If Mr. Wagner will look at my sketch he will see a parting in the upright pipe to show that the oil cup could be placed at any height above the crank.

If it was desired to use grease, a compression grease cup could be used instead of a sight-feed oil cup; but in such a case also there should be the union and the support, as it would be more troublesome to screw the cap on a compression cup that was revolving, or to tell how much the cap had been turned to force the grease to the pin, than in the case of a stationary cup.

The cup should have a support; otherwise it is likely to be knocked out of true and wabble.

DANIEL ASHWORTH.

Wappingers Falls, N. Y.

A Pumping Problem

Mr. Crockett's pumping problem on page 932 of the Dec. 19 issue is what has sometime been regarded as an anomaly in the practical working of centrifugal pumps. At first sight, it might be inferred that a decreased head would decrease the load on the engine which drives the pump, but the opposite effect is often observed.

This is easily understood when it is considered that the power required is proportional directly to the rate of discharge and head, and inversely to the efficiency. A decrease in the head causes an increase in the rate of discharge and probably a decrease in the efficiency, so that the net result may be an increase in the power, as seems to be the effect in this case.

W. L. DURAND.

Brooklyn, N. Y.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Ratio of Expansion

What is meant by ratio of expansion?

M. D.

Divide the length of stroke in inches by the number of inches traveled by the piston before the steam is cut off. The quotient will be the ratio of expansion.

To be accurate the clearance should be added to both quantities before dividing.

Two Eccentrics for Corliss Engines

What is gained by having two eccentrics on the low-pressure side of a compound-condensing engine?

M. J. G.

By using two eccentrics, the steam and the exhaust valves may be set separately, thus permitting a longer range of cutoff for the steam valves and an earlier opening of the exhaust valves and allowing the benefit of the vacuum earlier.

Size of Steam Pipe for Engines

What should be the size of the steam pipe in reference to the size of the cylinder?

J. B.

There is a wide variation in practice regarding the size of steam mains. Each case should take the length and directness of the connections into consideration. A general rule is: Multiply the square root of the horsepower by 0.408.

Point of Cutoff of a Common Slide Valve

Why does not a slide valve cut off in the first half of the stroke?

J. A. C.

The point of cutoff of a simple slide-valve engine is fixed. The speed is controlled by the throttling effect of the governor. For a common slide valve it is not practicable to cut off the steam supply to the cylinder sufficiently early in the stroke as to effect so large a degree of expansion as by a Corliss or other type of valve, because it would require a valve having an excessive amount of outside lap and the exhaust would take place too early in the stroke. Slide valves work to better advantage when the lap is so proportioned as to cut off the steam at from two-thirds to three-quarters of the stroke than at any other point, because of the comparatively long stroke of the valve when more lap is added and the great amount of friction between the valve face and its seat.

Lubricator Piping and Lubrication

Is it good practice to extend the lubricator pipe into the steam pipe? How can I get more lubrication at the valve ends? What is the record for the minimum amount of oil used? Is oil dangerous in a boiler?

D. C. Y.

The lubricator pipe should not extend into the steam space of the main pipe, but should end so that the oil will run down the side of the pipe. Oil grooves cut in the ends of the valves will sometimes aid in getting the oil where it will do its work.

The least quantity of oil used of which there is any record was one drop every two minutes on a 500-hp. compound Corliss engine. Some engines especially in the marine service are run without cylinder lubrication.

It makes a great deal of difference what type of boilers is used as to the danger from oil. With the tubular type, too much care cannot be taken to keep them free; with the water-tube there is much less danger.

Equalizing Clearance

How is the clearance in the cylinder equalized if the piston rod is keyed in the crosshead? How can I get more power out of an engine?

J. K.

The clearance on the cylinder of an engine where the piston rod is keyed in the crosshead can be equalized by adjusting the shims in the connecting-rod boxes. Increasing its speed or its pressure, or putting a condenser upon it, will get more power out of an engine.

Boiler Thimble

What is a boiler thimble?

T. U.

The thimble on a boiler is a ring or bushing placed between the tube and the tube sheets. It is used more in locomotive and marine than in stationary boilers.

Induction Heater

What is an induction heater?

A. L. F.

An induction heater is a dead-end heater having only one opening and connected to the exhaust pipe through a shunt. Part of the steam rises through the opening and is condensed, the water going out at the usual drip and more steam entering the heater to take the place of that which is condensed. Induction heaters are used in places where it is not convenient to place a thoroughfare heater.

Corliss Engine Valves

Is it possible to have all four valves of a Corliss engine closed at one time when the engine is running full speed?

F. A. T.

Yes; if the exhaust valves have lap so that one is closed for compression before the other opens for release. One steam valve will have dropped, the other will not have opened; hence all four valves will be closed.

Priming and Foaming

What is the difference between priming and foaming? What is the remedy for each?

M. K. L.

A boiler primes when water is mechanically carried over with the steam. This is due to forcing, to carrying the water level too high, or to restricted spaces between the tubes, thus making the steam come up in gulps and breaking up the surface of the water. The remedy is to carry a lower water level, take out the central row of tubes in a horizontal return-tubular boiler, keep the feed constant and uniform so as to preserve a constant condition of circulation, and have the rate of operation within that at which the boiler will furnish practically dry steam. When a boiler foams, the contents get frothy. The condition may be brought about by dirty water or by water in which an excess of soda has been used.

Lyons, France, is insisting on a more rigid observance of its smoke laws.

Boiler Explosion in Roswell, N. M.

By J. D. Hudgins

Baty's steam-laundry plant at Roswell, N. M., was the scene of a boiler explosion on the morning of Dec. 21. One man was seriously injured and 15 others experienced a miraculous escape. The writer was in the immediate vicinity of the accident when the explosion occurred and reached the scene about one minute afterward. Upon arrival it was noticed that the tubes exposed by the rupture, shown in the photograph, were at a dark red heat. The boiler was of the return-tubular type 36 in. in diameter and 12 ft. in length, having thirty 3-in. tubes, and was used to heat water for laundry purposes; it was also required to carry 65 lb. steam pressure, gage, for drying and ironing.

View of the Boiler after the Explosion

Upon inquiry it was learned that in closing down the plant at night the practice was to bank the fires and that when the fireman returned the following morning it was not uncommon to find that the fires had burned out, evaporating the water until it did not show in the gage-glass; the noise made by the safety valve, and its disturbance of the people living in the neighborhood is evidence of this fact. The boiler was equipped with an injector for supplying the feed water, and it required a steam pressure of 25 lb. for the 2-ft. lift from a barrel near-by. The first duty of the fireman, as he saw it, was to raise steam and then fill the boiler with water, which he invariably did. Nothing happened from this practice until the morning mentioned above.

Allis-Chalmers Co. in Financial Difficulties

Believing that the Allis-Chalmers Co., of Milwaukee, Wis., could no longer profitably continue its business and meet its obligations, its directors decided, on Dec. 29, to precipitate the company into a receivership by defaulting the interest on its first-mortgage bonds, on Jan. 1.

The stockholders' and the bondholders' committees are working upon a plan of readjustment and upon going to press it is learned that the receivership will be held in abeyance, temporarily at least.

When the company announced its default on the January interest, it became known that Judge Gary had resigned as chairman of the board.

The company was incorporated in New Jersey in 1901 as a combination of four smaller Western manufactories of machinery. In 1903 and 1906 additional departments were added to the company's plants at Milwaukee, Chicago, Scranton and West Allis, Wis. In 1906 also the Bullock Electrical Works, at Cincinnati, were acquired by stock purchase.

The company has authorized $25,000,000 common stock and $25,000,000 cumulative 7 per cent. preferred stock. There is outstanding about $19,820,000 common and $16,150,000 preferred. The par of both is $100. The preferred stock is convertible into common. Dividends at the rate of 7 per cent. a year were paid on the preferred from July, 1901, to Feb. 1, 1904, inclusive. Since then there has been none and that 7 per cent. a year has been accumulating as an obligation. No dividends have ever been paid on the common stock.

The company's bonded debt consists of $11,148,000 first sinking fund gold 5s, dated July 1, 1906, and due July 1, 1936. Its accounts show that in the fiscal years 1905-06 and 1906-07 there were good-sized deficits. In 1907-08 there was earned on the preferred 3.81 per cent., in 1908-09 0.84 per cent. and in 1909-10 3.07 per cent.

PERSONAL

A. G. Roberts has been appointed chief engineer at the municipal lighting plant of Pasadena, Calif., succeeding W. M. Glass, who recently resigned.

Walter J. Jones, consulting engineer, 30 Church St., New York City, has been appointed engineer to the electrical commission of Montreal, Quebec. He will have immediate supervision over the work of gathering data and laying out a complete municipal underground system for that city.

F. C. Holly, chairman-secretary of the Col. Goethals Branch No. 1, at Yazoo City, Miss., has resigned this position on account of his removal to Memphis, Tenn., where he is superintendent of the Perkins Oil Co. W. G. Richardson has been elected to fill the position made vacant by Mr. Holly.

OBITUARY

Allan Harris Crowell, vice-president of the William A. Harris Steam Engine Co., of Providence, R. I., died at Channing Hospital, in that city, on Dec. 27. He was the only son of E. Francis Cromwell, secretary and treasurer of the company. Death was due to intestinal indigestion, from which he had been suffering since Nov. 1. Mr. Cromwell was about 25 years old and had been associated with his father in business since leaving school. He is survived by a widow and two children.

Edward Sawyer, widely known as a civil engineer and an authority on the construction of water and sewer systems, died at his home at Newton, Mass., on Dec. 27. He was 73 years of age. Mr. Sawyer, in partnership with J. Herbert Shedd, constructed the sewer and water systems in the city of Providence. He also had a large share in the engineering problem of the division of water for power purposes along the Blackstone River, had charge of the construction of the power plant of the Chicopee Mills, was one of the founders of the Sawyer Spindle Co., of Boston, and since his retirement from more active work had served as consulting engineer on the Cochituate water plant, from which the city of Boston receives most of its water supply, and for other large water systems. He was a member of the American Society of Civil Engineers, the Boston Society of Civil Engineers and the Boston Society of Arts.

Moments with the Ad. Editor

Some time ago the Federation of Trade Press Associations and the American Trade Press Association held a joint banquet in New York.

The members of these associations are publishers of trade and technical papers.

Let us say right here that there is a general misunderstanding of the meaning of "trade" and "technical" as applied to papers. The word "trade" is a general term wrongly used to cover every kind of a periodical outside of general and religious magazines. As a matter of fact a *trade* paper is one which appeals to *dealers* in different industries who buys goods to sell at retail. The *technical* paper—of which POWER is an example—appeals directly to *users* and *buyers* of goods.

At this banquet one of the interesting and instructive speeches was delivered by Wm. H. Ingersoll, advertising manager of R. H. Ingersoll & Bro., makers of the famous Ingersoll watch.

Probably every man in the country has heard of Ingersoll watches and millions carry them. Fourteen thousand are made and sold every day.

"The world lives on two things," said Mr. Ingersoll, "the production of goods and the distribution of them."

Distribution of goods means the selling of them. Mr. Ingersoll pointed out very clearly that any method of distributing goods costs real money, and that the most economical method was advertising. Hence, advertising, instead of adding to the cost of goods, actually reduced the cost by using the most economical method of selling that is known—which is a point made recently on this page.

When a concern succeeds as Mr. Ingersoll's concern has succeeded, in making and marketing an accurate time-keeper at $1.00 retail, it proves the point.

At a general meeting of salesmen of the Ingersoll Company, it was shown that every time a seven-jewel, or better grade of watch is sold, a workman is given and paid for a day's work. These are watches retailing for more than $1.00. And these salesmen went out with that thought in their minds; the advertising is being done with that thought behind it, with the result that both salesmen and advertising are booming the business.

Advertising is the greatest factor in distribution and upon distribution depend the salaries of all of POWER readers, and our own modest stipends. Why, then, should not the subject of advertising be of interest to every man old enough to know what it means?

Advertising can be a tremendous power for good or evil, depending wholly upon how it is conducted.

This power touches intimately the life of every man and woman.

Civilization comes about through the distribution of commodities, and the latter comes about through the transportation facilities of the country and the information of how, where and when to get what we want or what will be good for us—in other words, plain advertising.

If it were not for this distribution, you know as well as we that each community would be a world unto itself, and each would be living in a sort of "darkest Africa" condition.

Now, if this is true, and if advertising in some of its multiple forms is playing its big part in the good work, isn't it worth while to tell all we can about it to those of our readers who, now or some time, must buy things for use in their work?

BUSINESS ITEMS

The Stark Electric Ry. Co., of Alliance, Ohio, has ordered from the Westinghouse Electric & Manufacturing Co. three quadruple equipments of No. 304-A motors, in the installation of which the type L unit switch control will be used.

The Youngstown Sheet & Tube Co., of Youngstown, Ohio, has recently placed an order with the Westinghouse Electric & Manufacturing Co., East Pittsburg, Penn., for a total of 99 motors to be used in connection with its open-hearth plant. They will be used on cranes, charging machines, strippers, transfer tables, screw downs and blooming mills.

The Memphis Hotel Co., Memphis, Tenn., has ordered two Vulcan soot cleaners from G. L. Simonds & Co., 801 Steinway Building, Chicago, Ill. These cleaners are for the Peabody hotel, also for the Gayoso hotel. The Edison Illuminating Co., of Detroit, Mich., has also placed with G. L. Simonds & Co., its seventh order for a Vulcan soot cleaner to be installed at its Delray plant, near Detroit, Mich. This company has been using Vulcan soot cleaners for about six years.

On Jan. 1, 1912, Williamson Brothers Co., of Philadelphia, the American Ship Windlass Co. and the Taylor Stoker Co., of Providence, R. I., were consolidated under the name of the American Engineering Co. The manufacturing, sales and engineering departments of the several concerns have been concentrated at the works of Williamson Brothers Co., at Philadelphia, which have been materially enlarged by the addition of a number of modern buildings as well as the necessary special tools and equipment to enable the new company to build advantageously the products of the constituent concerns.

The American Metal Hose Co., Waterbury, Conn., has issued a new Price Folder E, which calls attention to the reduced prices it put into effect on Jan. 1, 1912. The price list covers all sizes; it illustrates the various styles of hose manufactured by the company and it gives instructions as to just what to specify in ordering flexible metal hose. This company has been in existence over three years, but for the first year did no manufacturing, importing all its hose from a German metal-hose factory with which it was connected. But for the past two years it has been manufacturing at its own new factory, in Waterbury, and today it is entirely separate from any foreign connections. Its business is showing a constant increase and the only complaint it has to make is that sometimes its hose lasts too long.

NEW EQUIPMENT

The Cole Motor Car, Indianapolis, Ind., will install a boiler.

The Paris (Tenn.) Coal & Ice Co. will erect an ice-making plant.

Ilo, Idaho, is having plans prepared for a water-works system.

The Trenton (N. J.) Power Co. has plans for a new power house.

The Textile Machinery Co., Reading, Penn., is in the market for a 150-hp. boiler.

Lewiston, Idaho, contemplates the erection of a municipal electric power plant.

The municipal electric-light plant, at Grand Saline, Tex., recently burned, will be rebuilt.

Manchester, Ga., voted to issue bonds for the erection of a municipal electric-light plant.

Benton Harbor, Mich., will build a new pumping station for the municipal water plant.

Hudson Falls, N. Y., has voted to install a gravity water system to cost about $175,000.

William J. Mackay will erect a cold-storage and fruit-packing plant at Hampden, Mass.

West Acton, Mass., contemplates the installation of a new water system to cost about $50,000.

The Jones-Chambliss Co., Jacksonville, Fla., is arranging to erect a new refrigerating plant.

The Fort Wayne & Springfield Interurban Ry. Co. will erect a new power house at Decatur, Ind.

The Union Ice Co., South Alameda St., Los Angeles, Calif., will erect a branch ice plant at Colegrove.

Meadors, Vaughn & Halleran, Nashville, Tenn., will erect a $40,000 addition to their ice plant.

H. D. Hanford, Seattle, Wash., is preparing plans for a municipal electric-light plant for Pasco, Wash.

The Pacific Gas & Electric Co., San Francisco, Calif., will build a new electric substation at Dixon, Calif.

The Frederick (Md.) Gas & Electric Co. will build an auxiliary steam plant at Millville, Md., to cost $100,000.

The plant of the Pulaski (N. Y.) Electric Light & Power Co. will be overhauled and new machinery installed.

The Vassar (Mich.) Milk Condensing Co. is erecting a new plant. Will need power and refrigerating machinery.

The Southwestern Traction Co., of Minneapolis, Minn., will build a power house in Mooresville, Ind., in the spring.

The Imperial Power Co., Chehalis, Wash., has awarded contract for reconstruction of its plant wrecked recently.

The Rochester, Syracuse & Eastern R.R. Co. will erect a new power house near its present location, at Lyons, N. Y.

The Pacific Fruit Express Co., San Francisco, Calif., is building a new cold-storage plant at North Yakima, Wash.

The Cleveland (Ohio) Electric Illuminating Co. will buy considerable power and other electric-light plant equipment.

Wm. G. Bronson, Jr., of Stillwater, Minn., and R. C. Wright, of St. Paul, will erect a cold-storage plant at Stillwater.

McMinnville, Ore., has voted $30,000 bonds for improvemnets and additions to its electric-light and water-works system.

The Pacific Telephone & Telegraph Co., San Francisco, Calif., contemplates erecting a new exchange at Porterville, Calif.

The Bay State Storage Warehouse Co., Lowell. Mass., will erect a large addition to be used as a cold-storage plant.

The Comer (Ga.) Light & Power Co. has been granted a franchise to construct and operate an electric-light plant.

The Hardman Rubber & Tire Co., Belleville, N. J., will increase the capacity of its power plant. Will install new engine.

The city council, Two Rivers, Wis., is considering increasing the output of its municipal electric-light plant and water-works system.

The Angola (Ind.) Light & Power Co. has been incorporated to furnish light and power by D. M. & A. J. Vesey and W. E. Mossman.

The Mercer (Penn.) County Electric Light & Heat Co. has been granted a franchise to build and operate an electric-light plant.

The Home Telephone Co., Los Angeles, Calif., will increase the capacity of its plant at Pasadena, Calif. About $25,000 will be expended.

H. S. Warren & Co., Detroit, Mich., will erect a market building on Fifth St., Portland, Ore. Large refrigerating plant will be installed.

The Athabasca Development Co., Nelson, B. C., plans for the erection of an electric power plant at its mining property, near Nelson.

F. Auerbach & Bros., Salt Lake City, Utah, will build a power plant on East Second St. in connection with their new department store.

The Cleveland, Painesville & Eastern Ry. Co. will erect a power house, at Painesville, Ohio, building and equipment to cost $116,000.

The Alaska Water, Light & Telephone Co., Valdez, Alaska, is planning the erection of an electric power plant in the Sulphide Gulch district.

The plant of the Webster Light & Power Co., 331 South La Salle St., Chicago, Ill., was destroyed by fire. J. G. Harris, chief engineer.

Centralia, Wash., has voted $100,000 bonds for installing modern water-works plant. Plans are being prepared by C. D. Atterbury, city engineer.

The Southern Sierra Power Co., San Bernardino, Calif., plans for the erection of a large electric power plant in the Sierra Nevada Mountains.

The city of Sherman, Tex., will install pumps and other machinery in its electric-light plant and water-works. Harvey McDuffie, superintendent.

The Great Northern Power Co. has awarded contract for the construction of a new power station at Logan Ave. and Twenty-eighth St., Superior, Wis.

Kelsey, Brewer & Co., Grand Rapids, Mich., have acquired the plant of the Boise (Idaho) Gas Light Co., and contemplate extensive improvements.

J. T. Barker and C. L. Nye, of Riverside, Calif., have acquired property at Beaumont, Calif., and plan the erection of an hydro-electric power plant.

The Spring Valey (Ill.) Coal Co. is contemplating the installation of belt conveyors to carry fuel from the tipples of each mine to the boiler department.

The woodworking and electric power palnt of the Western Oregon Lumber Co., at Linnton, near Portland, Ore., was destroyed by fire. Loss, about $200,000.

NEW CATALOGS

Morse Chain Co., Ithaca, N. Y. Catalog. Morse silent chain. Illustrated. 16 pages, 6x9 inches.

Armstrong Cork Co., Pittsburg, Penn. Catalog. Nonpareil high-pressure coverings. Illustrated, 72 pages, 5x7 inches.

The Houston, Stanwood & Gamble Co., Cincinnati, Ohio. Catalog. Steam engines. Illustrated, 36 pages, 6x9 inches.

The Goulds Manufacturing Co., Seneca Falls, N. Y. Bulletin No. 103. Single-acting triplex plunger pump. Illustrated, 20 pages, 7½x10 inches.

The Deane Steam Pump Co., 115 Broadway, New York. Bulletin D205. Triplex power pumps, vertical double-acting. Illustrated, 32 pages, 6x9 inches.

United Refrigerator & Ice Machine Co., Kenosha, Wis. Catalog C. Ice-making and refrigerating machinery. Illustrated, 26 pages, 7x10½ inches.

Westinghouse Electric & Manufacturing Co., East Pittsburg, Penn. Bulletin No. 1198. Alternating-current water-wheel generators. Illustrated, 16 pages, 7x10 inches.

Engineers Wanted

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

CHIEF ENGINEER for power plant in suburban district Massachusetts; 500 boiler hp., 2300 volts, furnishing light, heat and power for institution; modern, uptodate plant; salary, $100 per month. Box 556, Power.

CHIEF ENGINEER for power plant near New York; 3000 boiler hp., furnishing light, heat and power, 2300 volts; shower bath and all modern improvements; minimum salary, $150 per month. Box 555, Power.

WANTED—Chief engineer for water and light plant, Curtis turbines; give full information as to experience, present employment and salary expected; none but experienced engineers need apply. Wabash Water & Light Co., Wabash, Ind.

WANTED—Chief engineer for a plant in Manhattan vicinity; must be a man of executive ability, capable of taking charge of producers and gas engines, steam engines and boilers, and pumps; also to have charge of all machinery repairs in a large manufacturing plant; in replying, give experience, age, references and salary expected. Address Box 559, care Power.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AGENTS WANTED—To sell popular steam specialty; commission basis only. Address "Rekcutaw, Post Office Box 363, New York.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co." Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

WANTED—Refrigerating engineer, 20-ton ice plant; will be required to do his own firing and repairing; permanent position. Address Box 217, Piedmont, W. Va.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

EXPERIENCED SALESMAN wanted, to sell best known vegetable boiler compound, used in every state by largest power plants. Address J. S. Wrinkle, Columbus, Ohio, 15 West Broad St.

MASTER MECHANIC wanted for pulp mill; used to construction and machinery installation; state age, experience and wages expected; application treated strictly confidential. Box 552, Power.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

STEAM ENGINEER and salesman desires to represent manufacturers of steam specialty; first-class goods only accepted. Address Box 557, Power.

ENGINEER, with stationary and marine experience, who is also a first-class machinist, for good reasons desires to make a change; at present chief of large plant. Box 558, Power.

POSITION WANTED by a single man, 28 years old, with mining company who require service of an engineer to take charge boilers, Corliss and high speed engines, dynamos and motors and air compressors. Address Box 554, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. C. P. Monash, 1417 W. Jackson Blvd., Chicago, Ill.

ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the offices of the company, in the Hallenbeck Building, 497-505 Pearl St., Borough of Manhattan, New York City, N. Y., on Tuesday, January 30, 1912, at 12 o'clock noon.

Dated, New York City, Dec. 19, 1911.
Robert McKean, Secretary.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—Five Corliss vertical water leg, and sixteen Manning vertical type boilers. J. & P. Coats, Ltd., Pawtucket, R. I.

FOR SALE—Three single-phase, 133-cycle, 1100-v. alternators, 250, 120 and 70 kw., with 15-panel marble switchboard; in operation until Jan. 15. Borough of Madison, Madison, N. J.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

IDEAL, simple engine, 14x14, 125 horsepower at 100 pounds pressure; rebuilt with new Chuse shaft, new piston and valve; in first-class condition; larger engine installed, reason for selling. F. A. Heermans, city clerk, Mattoon, Ill.

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Are You Sure That Your Gauges Are Absolutely Correct?

The American Dead Weight Gauge Tester will enable you to keep your gauges absolutely accurate.

It will turn doubt into certainty.

It will prevent all possible chance of misleading indications.

It will tell positively whether or not you are using coal economically.

The best of gauges become inaccurate through misuse or neglect.

It's your own fault if they stay that way.

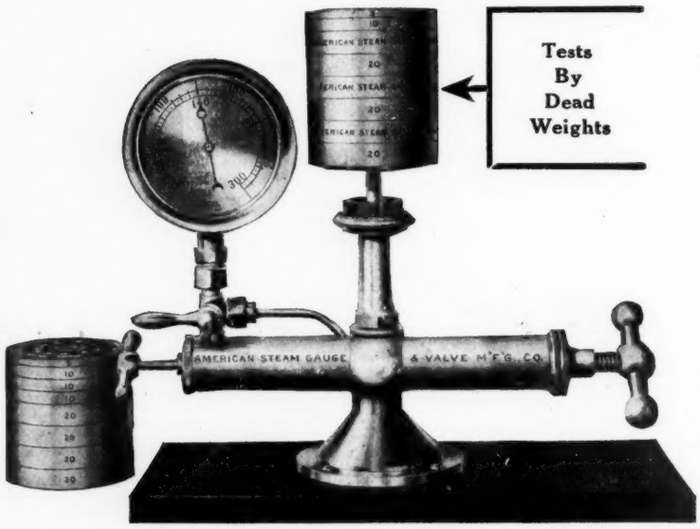
For here is the simplest, most compact and most reliable method for proving your gauges.

The American Dead Weight Gauge Tester has all the advantages of the mercury column in much smaller space.

It does not get out of order and it does not require repairing like the test gauge.

May we send you full details?

Have You a Copy of Our Fine Catalog?



Thousands of progressive engineers have the American Catalog on file.

They use it.

We want you to have a copy for your use.

We want you to know that it is a splendid reference work on power plant devices and the only way we can prove it is by getting a copy into your hands.

Therefore, dispite its size and cost we'll send you one without a penny charge or one bit of obligation on your part.

It will pay you to have this splendid book—for that is what it is—and we ask that you send for your copy now.

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